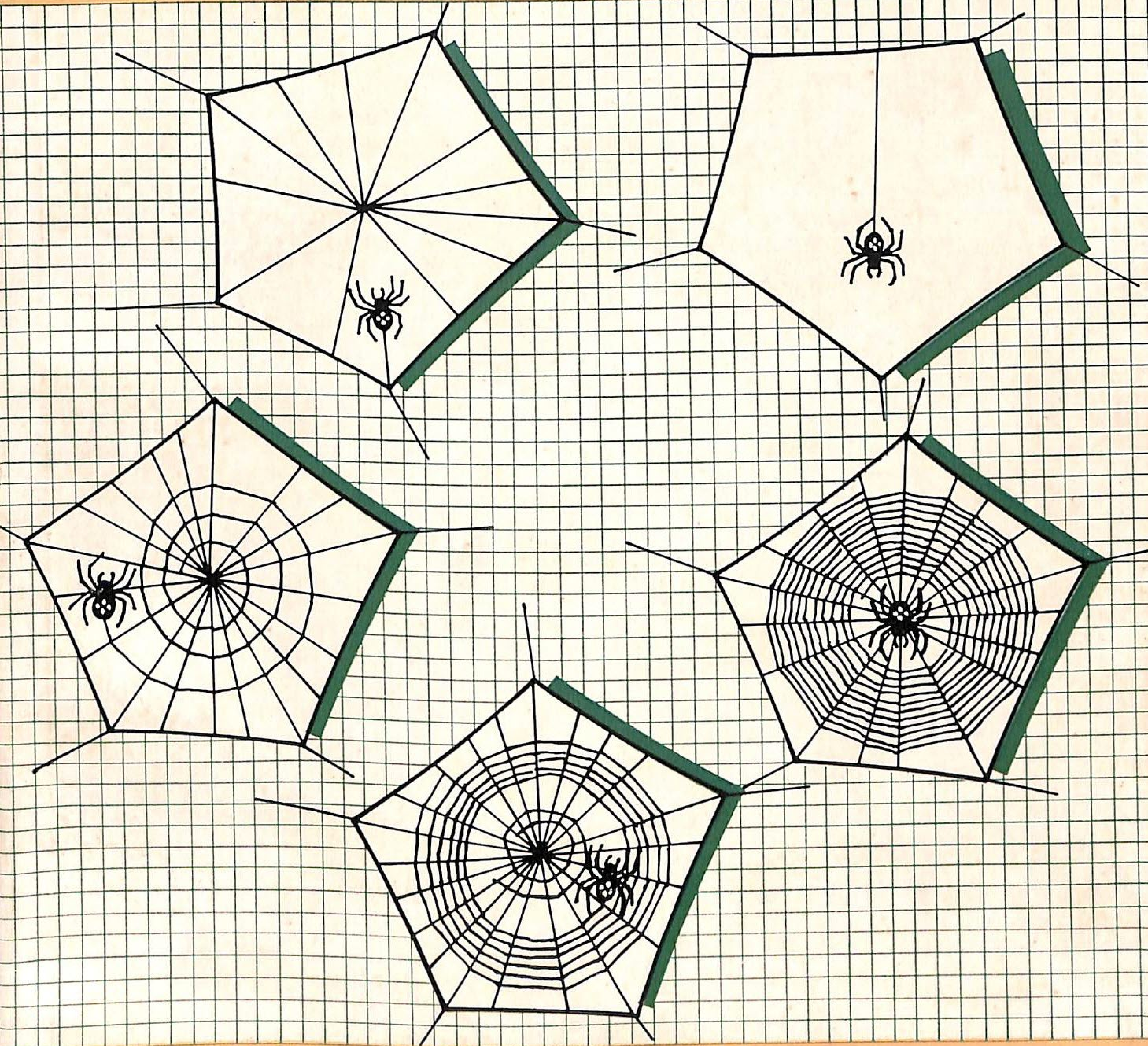
Understanding Science

BIOLOGY

Class VII



S. Menon • K. Mediratta • P. Theodore

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Preface

The Understanding Science series conforms to the guidelines laid down by the NCERT. While planning these books, our aim has been not only to adhere to the syllabus but at the same time, present the relevant concepts in biology in a lucid and absorbing manner in order to stimulate the interest of the student.

Keeping in mind the level of understanding of the student and his inherent curiosity at this age, the facts have been presented as an answer to his queries on himself and his environment, and also on their interaction and interdependence. Relevant illustrations supplement the topics and reinforce the concepts.

Easy-to-do activities have been included to encourage the students to collect, tabulate and interpret data. Carefully planned exercises at the end of each chapter enable the student to recapitulate and help the teacher to assess the comprehension of the student.

We hope this series enables the students to realise and appreciate the fact that a proper understanding of the subject is crucial to the very existence of mankind.

SHYAMLA MENON
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PROMILA THEODORE

September 1988

Contents

1

Structure of Living Beings

We know that living beings differ from the non-living. All of them exhibit certain common characteristics for e.g.,they require food, air and water to remain alive, they respond to the changing external environment, and so on. What makes living beings living? To know the answer to this question scientists did a lot of investigation.

Anton von Leeuwenhoek invented the microscope and Robert Hook observed a thin slice of cork under it, in the year 1665. He found that cork was made of tiny chambers or cavities and called them **cells.** All living organisms are made of these cells and based on the number of cells, there are three categories of organisms:

(i) organisms formed of a single cell and a single nucleus (**unicellular** organisms).

(ii) majority of plants and animals are formed of many cells having one nucleus in each cell (**multicellular** organisms).

(iii) many cells may combine together and their cell walls (partition walls only) may dissolve forming a continuous structure with many nuclei.

In 1835, a French biologist Dujardin discovered **protoplasm**, the basis of life. Later two scientists Schleiden and Schwann observed that all animal and plant cells contain protoplasm. On the basis of the observations made by various other scicentists it was concluded that:

The cell is the unit of protoplasm which carries out the various activities in plants and animals. Hence it is the *structural* and *functional* unit of life. It is the basic building block of tissues and organs, and only cells can divide to produce new cells, Fig. 1.1.

1.1 Structure and Composition of a Cell

Shapes of cells are adapted to their functions in multicellular organisms.The animal cells which line the organs are flat while the secretory cells are elongated. The cells are of different sizes as well. On an average an animal cell is 1/50th of a mm. while plant cells on an average are bigger than animal cells. You can get an idea about the varying sizes of cells found in nature from the fact that the smallest cells are those of bacteria while the largest are those of an egg of an ostrich. When you remove the shell and membrane of the egg the rest of it is a single cell.

The cell is bound by a thin membrane called

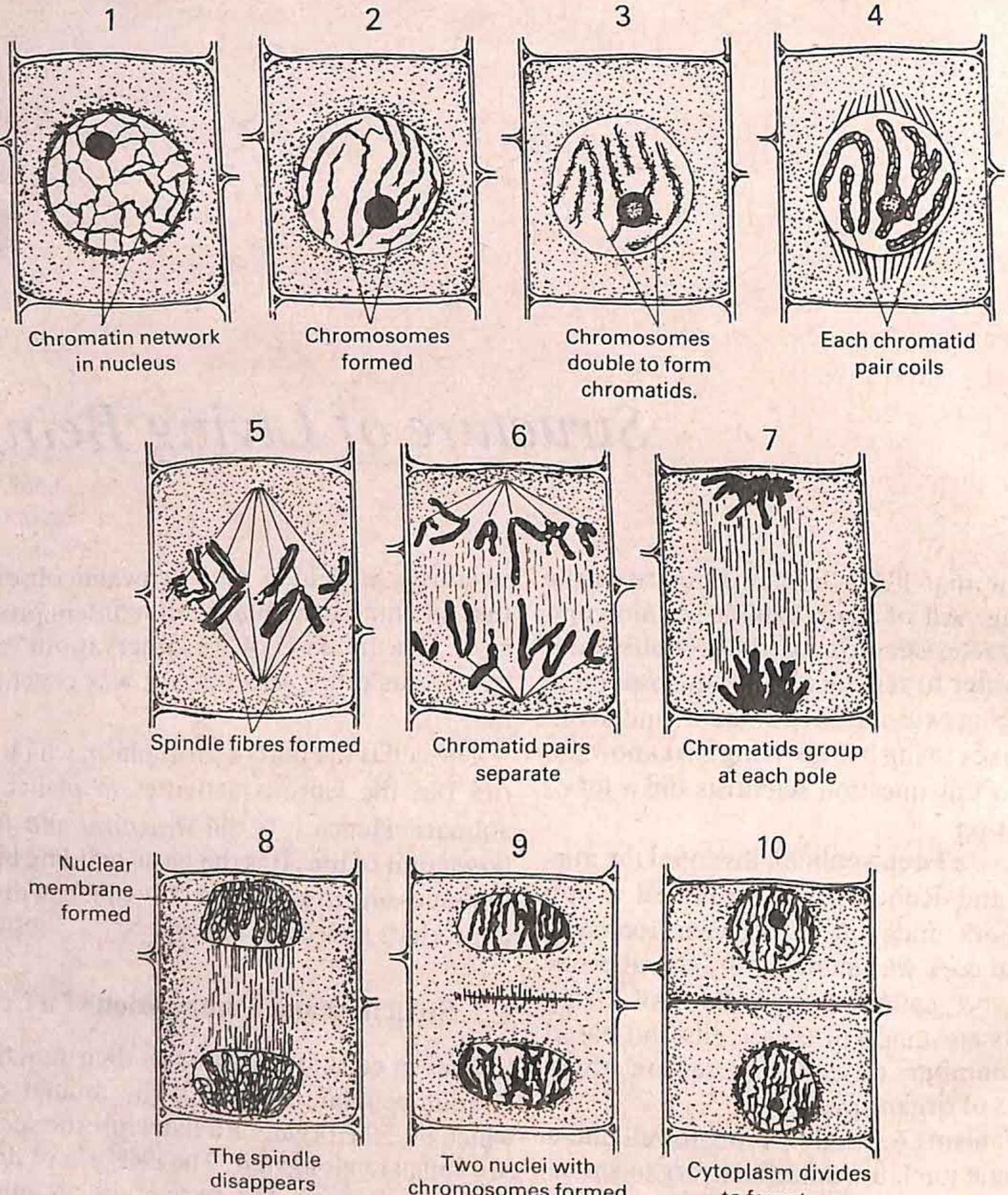


Fig. 1.1 Stages in mitosis

cell membrane or **plasma membrane** which encloses the jelly-like protoplasm. The cell membrane is *selectively permeable*, i.e., only certain substances can move in and out of the cell across it. In the protoplasm there is a spherical, dense and dark structure in the centre called **nucleus**, surrounded by a viscous fluid called **cytoplasm.** Food material is stored in the cytoplasm and it is here that complex chemical reactions take place, releasing energy for the life activities of the cell. New cytoplasm is also built up here.

The granule-like structures in the cytoplasm are surrounded by thin membranes and are called **organelles**, Fig. 1.2. The various organelles found in cytoplasm are:

(i) **Vacuoles**: They are sac-like structures containing dissolved cell nutrients and waste materials. This solution is known as **cell sap.**

(ii) **Centriole**: They are a pair of dot-like structures near the nucleus and help in cell division. These are present in animal cells only.

The remaining structures in the cytoplasm and nucleus are visible only under an electron microscope.

(iii) **Mitochondria**: These are rod-like structures and it is here that respiration (burning of food) occurs and energy is produced.

(iv) **Endoplasmic reticulum**: It is a network of membranes in the cytoplasm to which granules called **ribosomes** are attached. Ribosomes help in the synthesis of proteins in the cell. The membranes provide channels for the transport of materials.

(v) **Golgi bodies**: These are sacs of various shapes believed to help in the formation of hormones. They are also used for storing proteins, fats and carbohydrates.

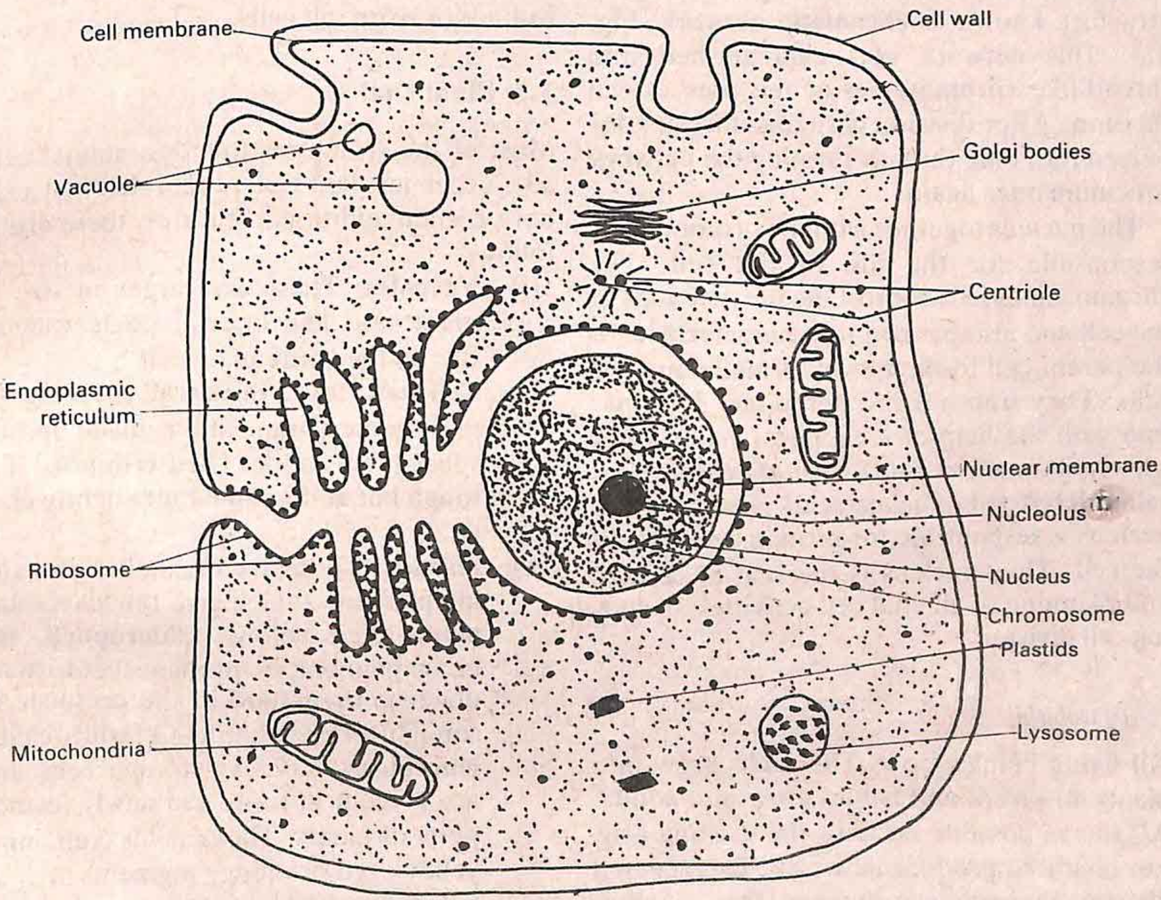


Fig. 1.2 A generalised cell.

(vi) **Lysosomes**: Found only in animal cells, these sacs contain chemicals which when released remove unwanted or dead cells. For this reason they are often referred to as suicide bags. They also digest food and other substances.

The Nucleus

Every cell has a nucleus. It is a dense, spherical body though its shape varies with the type of cell in which it is present. The protoplasm within the nucleus is called the **nucleoplasm** while the membrane surrounding it is known as the **nuclear membrane.** The nucleus also contains a spherical **nucleolus** denser than the surrounding nucleoplasm. In the nucleoplasm there are thin, threads forming a cobwebby structure known as **chromatin** network, Fig. 1.3. This network gets distinguished into thread-like **chromosomes** at the time of cell division. After division chromosomes get dispersed into long threads forming the network reticulum once again.

The nucleus together with the protoplasm is responsible for the life of the cell. The chromosomes in it control the life activities of the cell and also pass on the characteristics of the parent cell to the newly formed daughter cells. They transmit the hereditary information with the help of a chemical called **DNA** (deoxyribonucleic acid). Another chemical called RNA (ribonucleic acid) present in the nucleus is responsible for protein synthesis in the cell. Thus nucleus is the seat of control and planning of all vital cell activities, including cell division.

Cell Division

All living beings grow. The seeds grow into plants and trees and babies grow into adults. All this is possible because the existing cells can divide to produce new cells. By repeated division the cells can increase their number and also repair worn out cells. The cell first

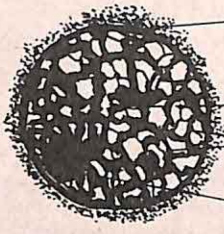


Fig. 1.3 The nucleus.

grows in size and then the nucleus divides into two and each nuclei goes to one end of the cell. This is followed by the cytoplasm dividing into two equal halves and two identical cells are formed, Fig. 1.1. This process is known as **mitosis**. Each new cell then grows and divides. This process continues as long as there is growth and also at the time of healing wounds or worn out cells.

1.2 Plant Cell

Most of the structures found in animal cells also occur in plant cells, Fig. 1.4. Plant cells have certain additional features, these are as follows:

(i) **Vacuoles**: These are larger in size in plant cells and often a single vacuole fills up the entire plant cell.

(ii) **Cell wall**: It is a thick wall covering the plasma membrane and is made up of a special substance called **cellulose.** It is tough but at the same time slightly elastic.

(iii) **Plastids**: These are organelles containing pigments which give the leaves and petals their colour. **Chlorophyll**, the green pigment, helps the leaves to manufacture their food in the presence of sunlight. The colourless plastids called **leucoplasts** serve as storage cells and are present in roots and newly formed parts of plants. The plastids containing yellow, red or orange pigments are called **chromoplasts** and they give colour to fruits and other plant parts.

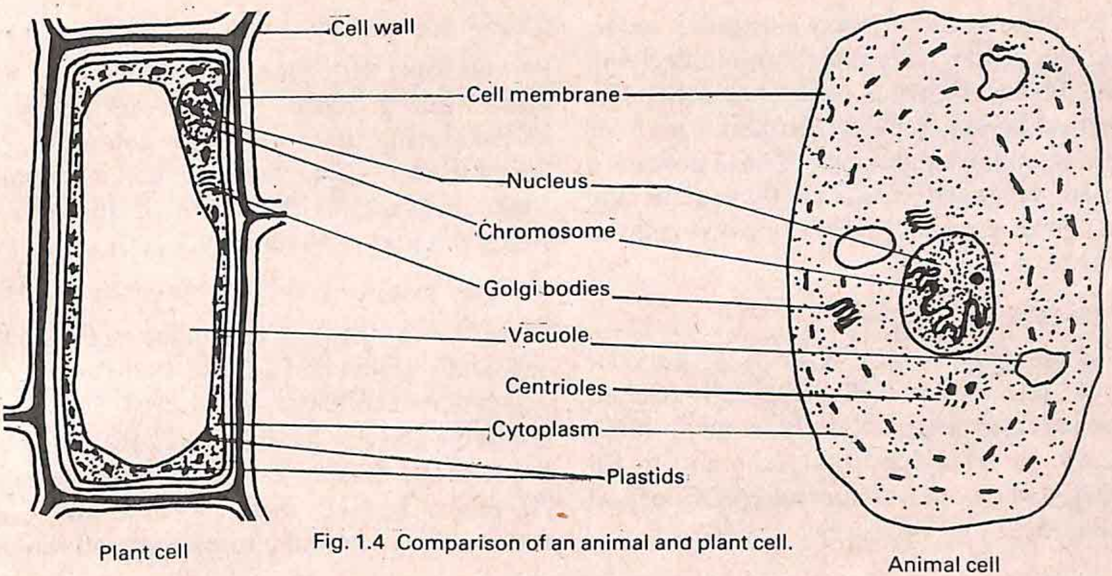


Fig. 1.4 Comparison of an animal and plant cell.

Nucleus in plant cells is pushed to one side instead of being in the centre due to the presence of large vacuoles. Cells of plants are interconnected by the strands of cytoplasm which pass through the pores present in the cell wall.

1.3 Tissues

In multicellular plants and animals we find that instead of each cell performing all the activities the work is distributed among groups of cells similar in structure. For example, some groups of similar cells perform the function of photosynthesis while others carry on only reproduction. Thus there is a *division of labour* among cells. Groups of cells become specialized structurally to carry on the given function, i.e., the cells which carry on photosynthesis have plenty of chloroplasts while those meant for reproduction have a prominent nuclei. These groups of cells, similar in structure and function are called **tissues.**

1.4 Plant Tissues

The important plant tissues forming the roots, stems and leaves are of three types:

(i) Meristematic tissue
(ii) Simple tissues
(iii) Complex tissues

The simple and complex tissues together are known as **permanent** tissues. These generally do not divide.

Meristematic tissue

Structurally it is the simplest plant tissue and it occurs at the tip of the growing stem and root. It is known as apical meristem and lacks chlorophyll. Their special feature is their ability to divide mitotically throughout the life of plants, i.e., they are perpetually young. In animals there is no special meristematic tissue as growth does not continue throughout life.

Simple tissues

Simple tissues are formed of one type of cells only. Some of the simple tissues are, epidermal tissue, chlorenchyma, parenchyma, collenchyma, sclerenchyma, etc.

Epidermal tissue

It consists of flattened irregular cells forming a layer called **epidermis.** This layer covers the surface of leaves, stem and root and is coated

with an impermeable, waxy substance called **cutin.** The epidermis protects the underlying layers. There are pores called **stomata** in the epidermal layers of the green aerial parts of the plant, mainly the leaves. These pores are guarded by **guard** cells and they allow the exchange of gases between the plant and the atmosphere, Fig. 1.5.

Parenchyma

It forms all the soft parts of the plant and consists of rounded or oval living cells packed tightly together, Fig. 1.6(a). Their major functions are to store food materials and to fill spaces between other tissues and provide food to the same.

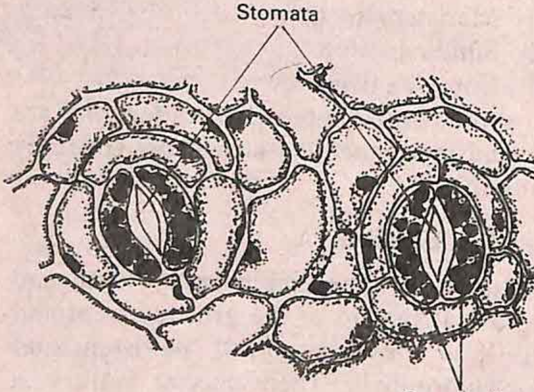


Fig. 1.5 Stomata in the epidermal layers.

Chlorenchyma

Parenchyma with plenty of chlorophyll pigments are grouped together in layers in leaves, giving them the green colour. These layers form the **chlorenchyma** and it prepares food, i.e., sugars with the help of chlorophyll, sunlight and carbon dioxide.

Collenchyma

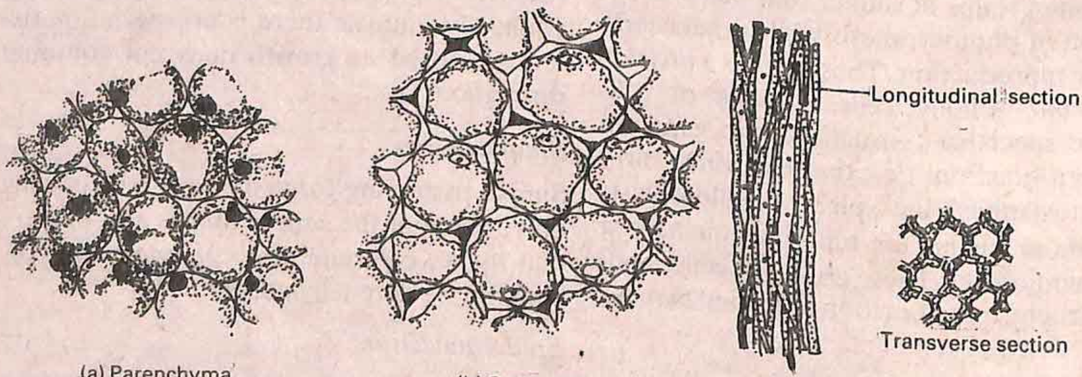
These are elongated parenchyma cells with cell walls thickened at the corners due to deposition of cellulose, Fig. 1.6(b). These cells are living and are flexible in nature. They are found in the flexible green branches of plants. At times the cells contain chlorophyll and therefore, can manufacture sugar and starch.

Sclerenchyma

It consists of tightly packed elongated cells, with tapering ends, Fig. 1.6(c). These cells are mostly dead and have walls thickened due to the deposition of **lignin.** They serve as bones to the plant giving it rigidity, strength and flexibility to withstand strain.

Complex tissues

These are also known as vascular tissues and are concerned with the transport of materials in plants. These are of two types, xylem and phloem.



(a) Parenchyma (b) Collenchyma (c) Sclerenchyma

Fig. 1.6 Simple permanent tissues

Xylem: Consists of **tracheids** and **vessels** and conducts water and mineral salts from the roots to the leaves. It is present in the root, leaf and stem of plants. This forms the main bulk of wood in all trees and also provides mechanical strength to the plant body.

Phloem: Mainly consists of unlignified living cells, the **seive tubes** and **companion** cells. The main function of phloem is to conduct food materials from the leaves through seive tubes to the other parts of the plant, i.e., roots, growing tips, fruits, etc. The companion cells help the seive tubes to function.

1.5 Animal Tissues

The main types of animal tissues are as follows:

(i) Epithelial tissue
(ii) Connective tissue
(iii) Muscular tissue
(iv) Nervous tissue

In each tissue the structure is always related to its function.

Epithelial tissue

It is a lining tissue in its simplest form. It consists of a single layer of closely packed, living cells. It lines the internal as well as external surface of the body and the organs within it. The main function of the epithelium is protective but in certain cases it may have secretory or digestive functions as well. There are different types of epithelial tissues present in different organs, Fig. 1.7.

Connective tissue

This is a special tissue which connects and binds the organs and tissues together. It also provides support and shape to our body. It consists of a ground substance in which variety of cells and fibres are embedded. Connective tissues are of different types, Fig. 1.8.

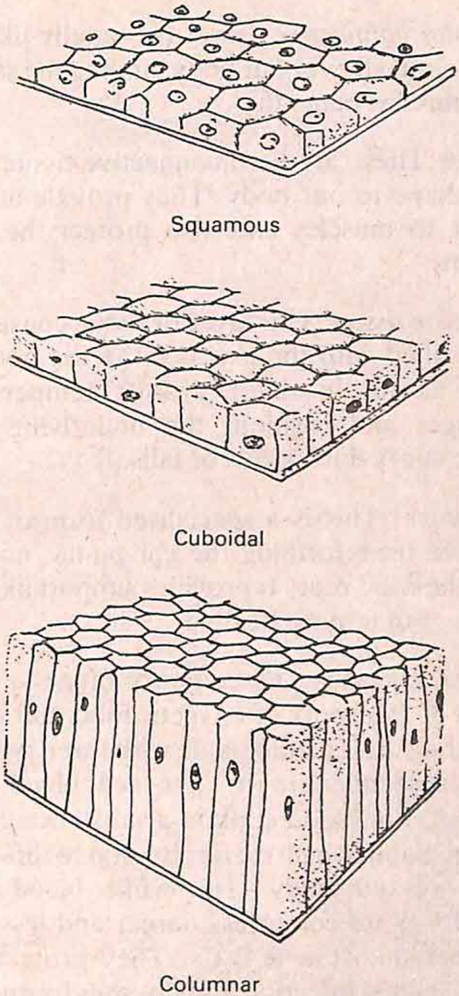


Fig. 1.7 Different types of epithelial tissues.

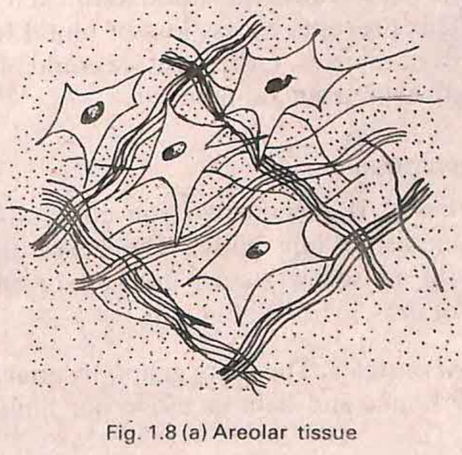


Fig. 1.8 (a) Areolar tissue

Areolar connective tissue: It is a jelly-like tissue found all over our body binding the skin to the muscles beneath it.

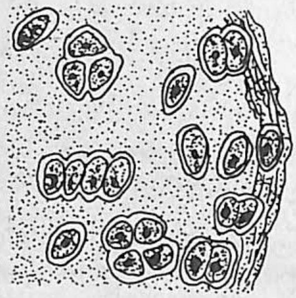
Bones: These are hard connective tissues giving shape to our body. They provide attachment to muscles and also protect the vital organs.

Adipose tissue: This layer of tissue consists oı cells filled with the excess fat in the body. It acts as an insulator against temperature changes and cushions the underlying cells from injury during cuts or falls.

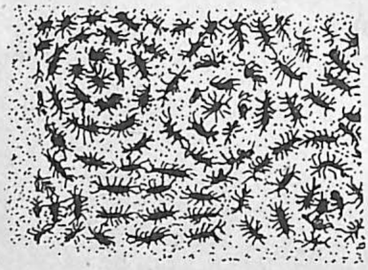
Cartilage: This is a specialised form of connective tisue forming the ear pinna, nostrils and the wind pipe. It provides support like the bones, but is more flexible.

Blood: Blood is a tissue performing the functions of transport of oxygen, food and other materials. It is a fluid tissue with three types of cells suspended in it. The **red blood** cells (R.B.C.) in blood contain a substance called **haemoglobin** which carries oxygen to different parts of our body. The **white blood** cells (W.B.C.) are colourless, larger and lesser in number than the R.B.Cs. They protect the body against infection and diseases by engulfing the disease-causing organisms.

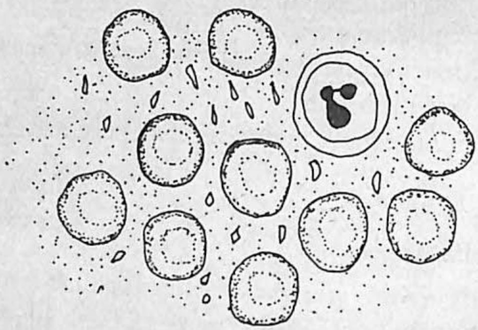
There are minute cell particles called **platelets** which cause the blood to thicken and clot. This prevents excess loss of blood from wounds or injuries. Otherwise we could bleed to death even from a simple cut.



(b) Cartilage tissue



(c) Bone tissue



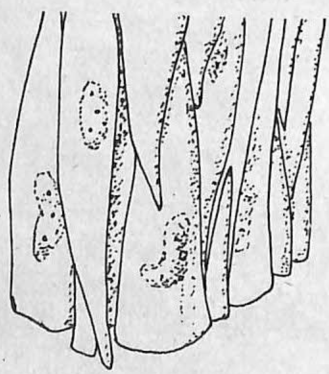
(d) Blood

Fig. 1.8 Example of connective tissue

Muscular tissue

This tissue is responsible for all kinds of movements in our body. There are three types of muscular tissues formed of three types of muscle fibres, Fig. 1.9.

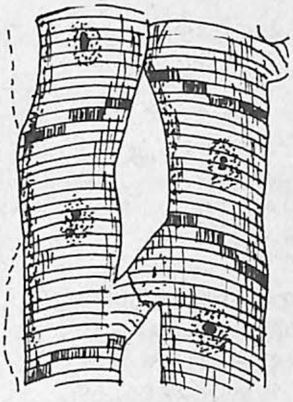
Striated muscles: These are generally attached to our bones and help us move our limbs at will.



Smooth

Striated

Fig. 1.9



Cardiac

Fig. 1.9 Muscle tissues

Cardiac muscles: These muscles form the heart. They work throughout our life tirelessly.

Smooth muscles: These are present in the hollow organs inside our body, i.e., intestine, stomach, etc. We cannot control their movements wilfully.

Nervous tissue

This tissue forms our brain, spinal cord and nerves. Its main function is to transmit electrical and chemical messages from one part of the body to another. This tissue consists of special cells called **neurons** which are interconnected to each other, Fig. 1.10. They are capable of storing information.

The different cells and tissues you have studied so far combine to form larger functional units called **organs.** For example, stomach, liver, heart, kidneys, etc., are organs in animals where as roots, stem, leaves, seeds and flowers are organs in plants. The organs in higher animals, together performing a particular function form an **organ system**, i.e., mouth, stomach, liver, intestines form the digestive system, Fig. 1.11. In plants the organs perform individual functions, without forming an elaborate organ system.

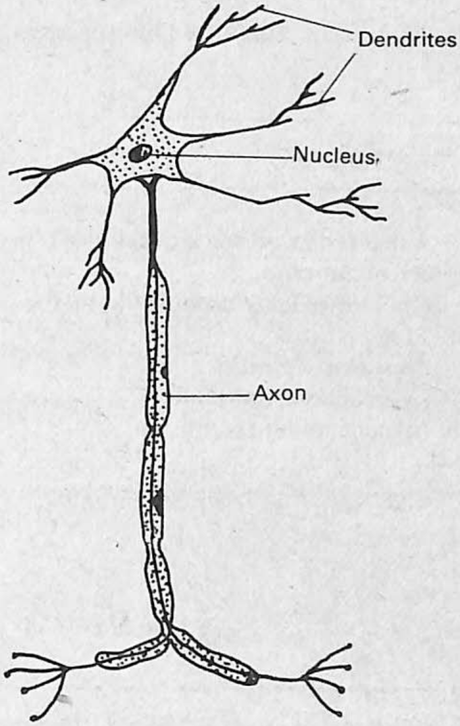


Fig. 1.10 Nerve cell.

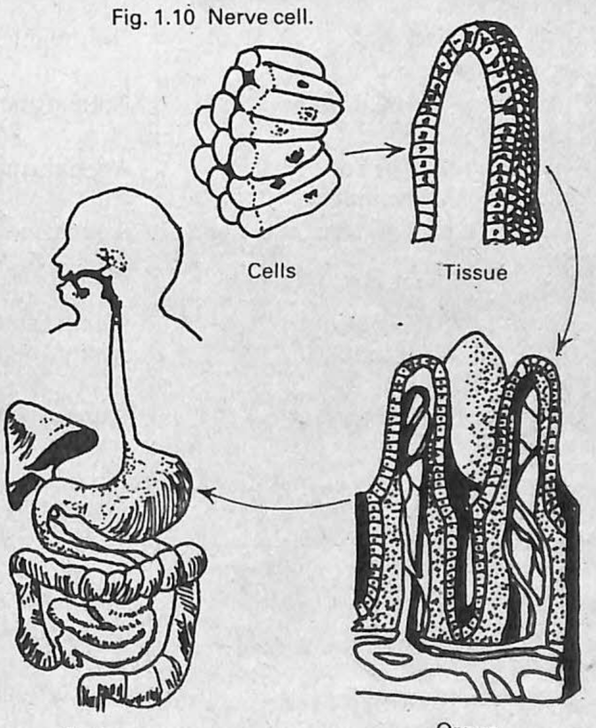


Fig. 1.11 Organisation of a system.

Table 1.1 Differences in Structure of Animal and Plant Cell

	Plant cell	*Animal cell*
1.	A dead cell wall made of cellulose surrounds the cell membrane.	Cell well absent.
2.	One or two large vacoule fills up the cells.	Several small temporary vacuoles present.
3.	Presence of plastids.	Absence of plastids.
4.	Lysosomes are absent.	Lysosomes are present.
5.	No centrioles present.	Two dot-like centrioles present.

Table 1.2 Cell Structures and Functions

	Cell structure	*Present in*	*Function*
1.	Cell wall	Only plant cells	Gives shape and rigidity to the cell and protects it as well.
2.	Cell membrane	Animal and plant cell	Regulates the movement of materials in and out of the cell.
3.	Cytoplasm	Animal and plant cell	Site of cell metabolism.
4.	Mitochondria	Animal and plant cell	Power-house of cell.
5.	Endoplasmic reticulum	Animal and plant cell	Helps in the formation of lysosomes and provides channels for transfer of materials.
6.	Ribosomes	Animal and plant cell	Responsible for protein synthesis.
7.	Golgi bodies	Animal and plant cell	Hormone formation, storing of proteins and fats.
8.	Lysosomes	Animal cell only	Digestion of food materials and removal of unwanted or dead cells.
9.	Nucleus	Animal and plant cell	Seat of control and planning of vital cell activities including heredity and DNA synthesis.
10.	Nucleolus	Animal and plant cell	Involved in protein synthesis.
11.	Vacuoles	Animal and plant cell	Storage and discharge of cell nutrients.
12.	Centriole	Animal cell only	Cell division.
13.	Plastids	Plants only	Store starch, impart colour to plant parts, help in photosynthesis.

EXERCISES

1. Explain the role of the nucleus.

2. Show with the help of diagrams the difference between an animal and plant cell.

3. Give the functions of the following cell organelles.

   (i) Mitochondria

   (ii) Ribosomes

   (iii) Lysosomes

   (iv) Vacuole

   (v) Plastids

4. What is the function of epithelial tissues in animals?

5. Explain briefly the components of blood and their functions. ______________________

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6. Match the following:

(a) Parenchyma	(i) give shape to our body.
(b) Adipose tissue	(ii) conduct water, food and mineral salts.
(c) Bones	(iii) gives strength and flexibility to plants to withstand strain.
(d) Collenchyma	(iv) forms all the soft parts of a plant.
(e) Nervous tissue	(v) structural and functional units of plants and animals.
(f) Vascular tissues	(vi) conducts messages from the brain to different parts of our body.
(g) Sclerenchyma	(vii) acts as an insulator against temperature changes.
(h) Cells	(viii) found in the flexible green branches of plants.

2

Classification of Plants

Life on earth has many diverse forms today. They differ not only in their structure but also in their habits, such as, ways of procuring food, etc. They may be rooted to one spot like plants or they may go hunting for food like animals. But inspite of all the diversity they are all composed of cells. It is believed that life on earth began from a cell and through the years evolved into the present day diverse and complicated forms.

Scientists studied the various forms of life and tried to classify them into groups on the basis of their similarities. They thought such a categorisation would simplify the study of the living forms and would make the identification of other similar forms easy. Aristotle classified plants into three groups, i.e., herbs, shrubs and trees. Later, some scientists classified plants into medicinal plants, poisonous plants, edible plants, etc.

Activity 1: Conduct a survey in your locality and classify the different types of trees.

The different classifications mentioned above posed several problems. Finally after observing the various life forms on the earth scientists came to the conclusion that during the course of evolution simple unicellular organisms must have appeared first followed by multicellular organisms. **Prokaryotes** were the first to arrive followed by **eukaryotes**. Among eukaryotes also first unicellular organisms appeared followed by multicellular eukaryotic organisms. Thus according to the new principles of classification all the living organisms are divided into two major groups, prokaryotes and eukaryotes. Let us study about these first forms of life.

Prokaryotes

Prokaryotes were probably the first to evolve on this earth. These unicellular organisms lack a distinct nucleus, instead, there is a thread of chromosome called **nucleoid**, Fig. 2.1. Prokaryotes lack endoplasmic reticulum, mitochondria and plastids as well. The cells generally reproduce by simple fission producing two daughter cells each. Examples of prokaryotes are bacteria and blue gree algae.

Eukaryotes

All the remaining plants and animals belong to this group. It includes unicellular as well as multicellular organisms. The important characteristics of eukaryotic cells are, they have a well defined nucleus,surrounded by a nuclear membrane, Fig. 2.1. Inside the nuc-

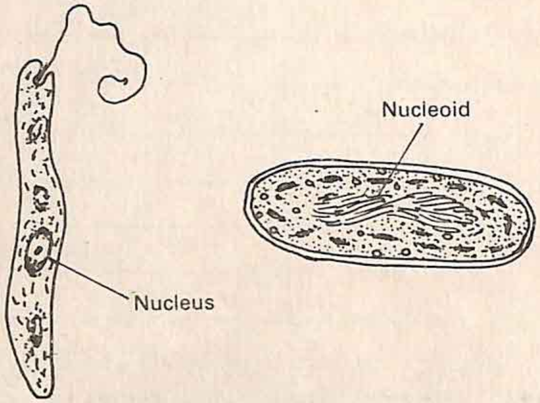


Fig. 2.1 The prokaryote and the eukaryote.

leus there is nucleoplasm unlike the prokaryotic cells. These cells have endoplasmic reticulum and mitochondria aswell. Some eukaryotes contain plastids and distinct sexual reproduction is a common feature in most of them.

Some prokaryotes and eukaryotes containing the pigment chlorophyll, trapped sunlight to prepare their own food from water and carbon dioxide. In other words they could photosynthesize. All eukaryotes and prokaryotes synthesizing their own food are called **autotrophs**. From these autotrophic unicellular organisms, multicellular plants developed. Hence all these unicellular and multicellular autotrophs are grouped under the **plant kingdom.**

All the prokaryotes and eukaryotes which could not photosynthesize depended on the autotrophs for food. They became **heterotrophic**. All unicellular and multicellular heterotrophs are grouped together in one division known as **animal kingdom.**

2.1. The Plant Kingdom

This is the highest category of plants comprising of prokaryotic as well as eukaryotic autotrophs. This main category is divided into smaller groups based on certain similarities and differences. The smaller groups are **division, class, order, family, genus** and **species,** the latter being the smallest. Species includes all the closely related forms which are similar in their habits and habitats. The mode of procuring food is also similar. The members within a species can interbreed but they cannot breed with those of other species.

The closely related species are grouped under a genus (plural genera). The members of a genus can breed to produce sterile offsprings only, i.e., the offsprings can not reproduce. For e.g., a white horse and a brown horse both belong to the same species. They can breed to produce a horse which can also produce offsprings in its turn. On the other hand a horse and a donkey belong to two different species but the same genus. They may interbreed to produce a mule which is sterile.

A number of closely related genera form a **family**. All allied families are included in an **order**. Several orders constitute a **class**. A few classes with certain common features are grouped together in a **division**. The entire plant kingdom is divided into two divisions namely the **cryptogams**, i.e., seedless plants and **phanerogams**, i.e., plants with seeds. The wide variety of plants all around us are classified under these categories.

Though classification grouped the plants in an orderly manner their identification posed a problem. Each plant had a different name in different languages. What we call *Aam* in Hindi is *Mango* in English and *Mangai* in Tamil. So a common method of naming the plants had to be evolved. Different scientists gave different methods of naming plants but each had its drawbacks.

Finally Carolus Linnaeus, an eighteenth century naturalist, simplified the system of naming plants and animals. He named every living plant or animal by two words in Latin. The first word always denoted the name of the genus and the second word the name of the species. The generic name starts with a capital letter. For example, peepal tree, banyan tree

and fig tree, all belong to different species but resemble each other as far as their fruits are concerned. Hence these three species are grouped under one genus called *Ficus*. Thus the scientific names for all the three above mentioned trees are:

Peepal: *Ficus religiosa*, Banyan tree: *Ficus bengalensis*, Fig tree: *Ficus carica*.

2.2. Classification

The plant kingdom is classified into various categories based on certain similarities and differences, Fig. 2.2.

Thallophytes

Plants belonging to this group have a filamentous body. The plant body is not differentiated into root, stem and leaf, Fig. 2.3. It includes virus, bacteria, algae, fungi and lichens. This is a group of nonflowering plants.

Activity 2: Take a piece of bread, moisten it slightly and put it in some damp corner. Leave it for a few days. Fluffy yellow, blue or black growths appear. This is nothing but fungus.

Bryophyta

These are multicellular green plants, more

PLANT KINGDOM

- **Thallophyta** (Virus, Bacteria, Algae,) Fungi, Lichens
- **Bryophyta** (Moss, Liverworts)
- **Tracheophyta** (Vascular plants)
  - **Pteridophyta** (Ferns)
  - **Spermatophyta**
    - **Gymnosperms** (Pines)
    - **Angiosperms** (Flowering plant)
      - **Monocotyledons**
      - **Dicotyledons**

Fig. 2.2 Classification of the Plant Kingdom.

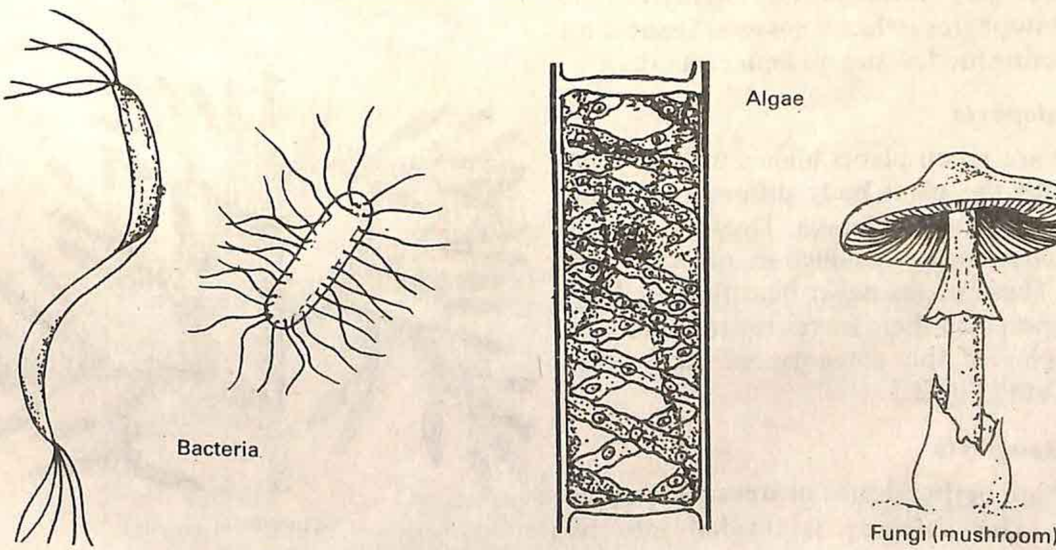


Fig. 2.3 Diverse forms of thallophytes.

complex than algae, fungi, etc. The plant body is either developed into true tissues or it is differentiated into structures similar to root, stem and leaf. These plants lack conducting tissues and do not bear flowers. Liverworts and mosses fall into this category, Fig. 2.4.

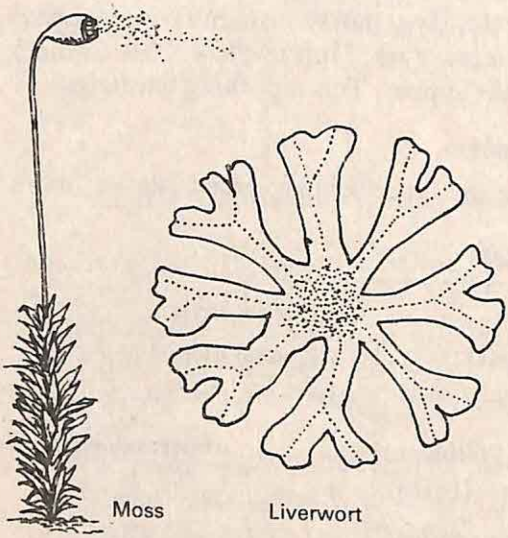


Fig. 2.4 Bryophytes are more advanced than thallophytes.

Tracheophyta

This category includes Pteridophytes and Spermatophytes which possess tissues for conducting food, water and mineral salts.

Pteriodophyta

These are green plants higher than Bryophtes, with the plant body differentiated into true root, stem and leaves. They possess vascular tissues for conduction of water and food. These plants never bear flowers. They bear spores on their leaves for reproduction. Examples of this category are ferns, clubmoss, etc., Fig. 2.5.

Spermatophyta

These are herbs, shrubs or trees and produce seeds. This category is divided into two groups, **gymnosperms** and **angiosperms**.

Gymnosperms

The plants belonging to this category always bear naked seeds, i.e., the seeds are *never enclosed within a fruit*. These plants are either shrubs or trees. Common examples of this group are cycads and pines. They have well

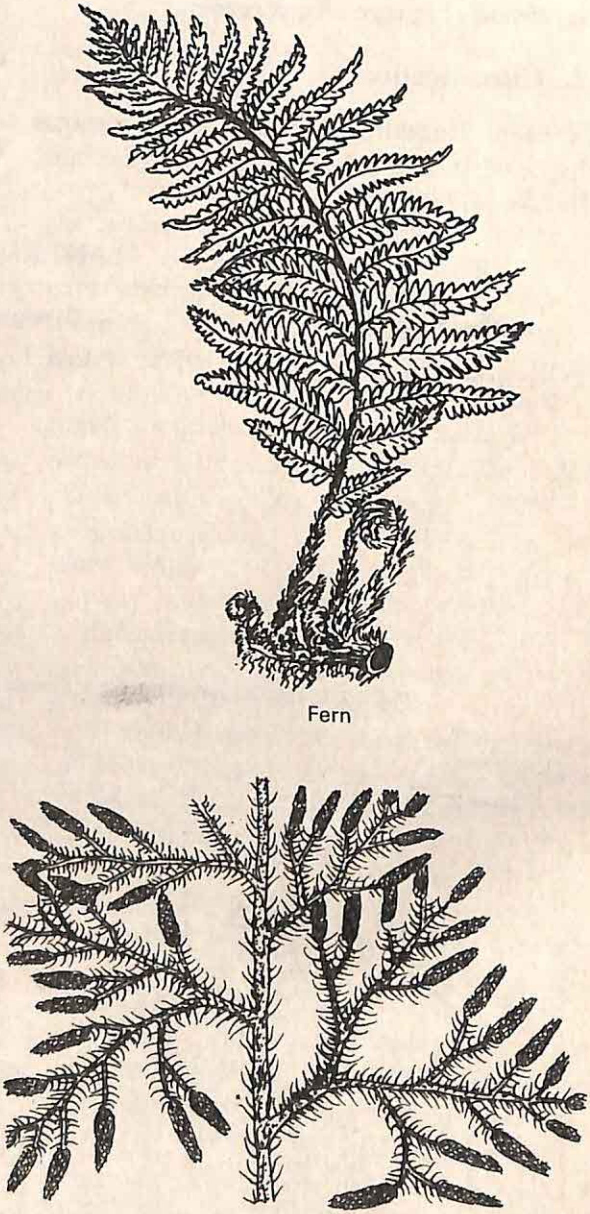


Fig. 2.5 Some pteridophytes.

developed root and shoot systems with proper vascular system for conduction of water and food. Unlike angiosperms the xylem of gymnosperms lack vessels and phloem lacks companion cells. The pine leaves are reduced to needles so that evaporation of water from them is minimum.

These plants bear reduced unisexual flowers in clusters. These clusters of male and female flowers are known as *cones*, Fig. 2.6(a). You must have seen pine cones lying on the ground in hilly areas. These are the female cones. The inner surface of the scales of the female cones bear the seeds. The male cones are in clusters and are smaller in size.

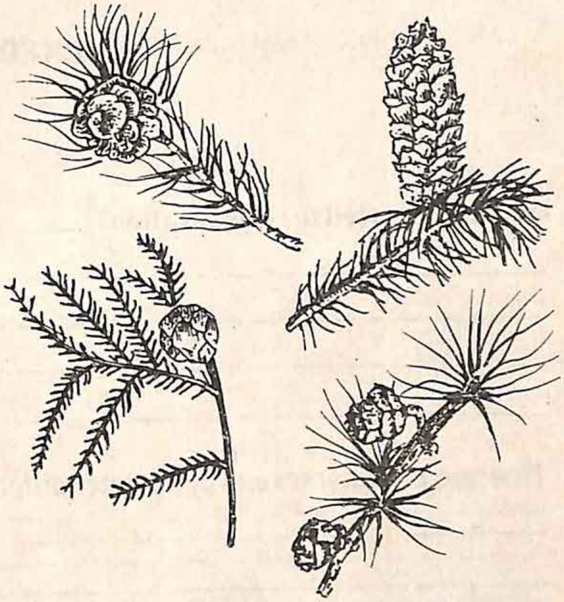


Fig. 2.6(a) Diversity among gymnosperms.

Angiosperms or Flowering Plants

The angiosperms are superior to all the above mentioned groups of plants. All plants belonging to this group bear proper flowers, Fig. 2.6(b). The seeds are always enclosed in a fruit. The plants can be herbs, shrubs or trees. These plants have a very well developed vascular system. Xylem has vessels as well as tracheids and phloem has sieve tubes and companion cells.

This is the most evolved group of plants, widely distributed over the earth. It is divided into two sub groups, monocotyledons with one cotyledon in the seed, for e.g., wheat and rice and dicotyledons with two cotyledons in the seed, for e.g., pea, bean.

Other differences are in their roots, stem and leaves.

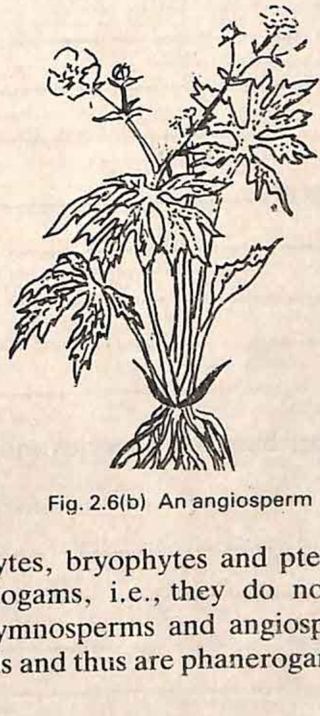


Fig. 2.6(b) An angiosperm

Classification of plants can be summarised as in, Fig. 2.7.

Prokaryotes — Bacteria, Blue-green algae

Eukaryotes — Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Spermatophytes

Thallophytes: Bacteria, Blue-green algae, Algae, Fungi, Lichens

Spermatophytes — Gymnosperms, Angiosperms

Angiosperms — Monocot, Dicot

Tracheophytes: Pteridophytes, Spermatophytes (Gymnosperms, Angiosperms — Monocot, Dicot)

Fig. 2.7 All the groups of the Plant Kingdom can be divided into prokaryotes and eukaryotes.

Thallophytes, bryophytes and pteridophytes are cryptogams, i.e., they do not produce seeds. Gymnosperms and angiosperms produce seeds and thus are phanerogams.

EXERCISES

1. What is the need for classification?

2. How are prokaryotes and eukaryotes different from each other?

3. Autotrophs are:

4. Differentiate between a species and a genus.

5. Give the botanical names of the following:
   (i) Peepal
   (ii) Banyan
   (iii) Fig tree

6. Draw a chart to show the different groups into which the plant kingdom is divided

7. Write in brief about the following:

(i) Thallophytes ______

(ii) Bryophytes ______

(iii) Pteridophytes ______

(iv) Gymnosperms ______

(v) Angiosperms ______

3

Flowerless Plants

In the preceeding chapter we learnt how plants evolved from a single cell. The **prokaryotes** were the first to appear on this earth followed by unicellular and multicellular **eukaryotes**. From the simple eukaryotes such as algae, fungi, lichens, the mosses evolved. The ferns were the next to follow with the pines in tow. All these are nonflowering plants and with the exception of gymnosperms, do not produce seeds. It was the angiosperms, i.e., the monocots and dicots which changed the trend. They produced flowers of different shapes, colours and sizes instead of the reduced clusters of flowers in gymnosperms.

In the foregoing discussion you have seen how all the nonflowering plants differ from the angiosperms. Let us now see the diversity among the flowerless plants.

3.1 Bacteria

Bacteria are the smallest, oldest and most abundant group of organisms in the living world. They are unicellular and do not have a distinct nucleus. They are of different shapes and sizes, Fig. 3.1. They are found almost everywhere including the icy poles, the boiling hotsprings and in the dark depths of oceans. They are present in the air that envelopes us, the soil we walk on, the food we eat and the water we drink.

Most bacteria do not contain chlorophyll and thus cannot prepare their own food. They may feed on organic compounds present in the soil, i.e., the partially decayed plants and animals. They decompose dead animals and plants into soil, minerals and gases. This

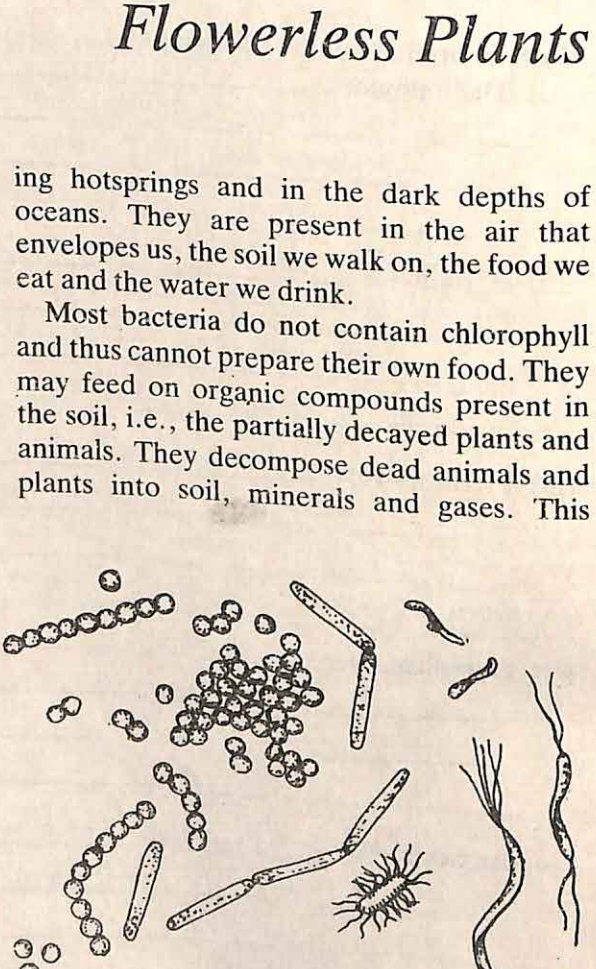


Fig. 3.1 Bacteria of different types.

enriches the soil and growing plants can use the minerals from the soil. They also decompose fallen leaves, vegetable garbage, cowdung, etc., dumped by the farmer in a pit. The manure thus formed is very useful in restoring the soil balance.

The other heterotrophic bacteria obtain their food from living beings. They enter our body and that of other animals and plants along with the food, air or water. They may even enter through a wound and live inside the living organisms as **parasites**. They damage the host and cause a number of diseases. For example, they cause cholera, tuberculosis, typhoid, pneumonia, tetanus, etc, in man. They spoil our cooked as well as uncooked food and on eating it we may suffer from food poisoning.

The conditions in summer are favourable for their growth so instances of spoilt milk, food, etc., are common in summer. They attack our crops during cultivation and storage causing excessive damage. The mature bacterial cell divides into two cells by narrowing in the middle, Fig. 3.2. Under favourable conditions they can multiply every twenty minutes. Also under unfavourable conditions bacteria can develop a thick wall around itself and tide through the bad times.

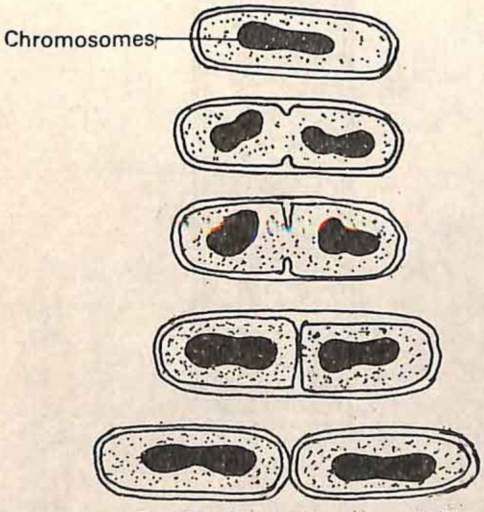


Fig. 3.2 Cell division in bacteria.

You must be thinking that the situation is so dismal that all animals and plants are completely at the mercy of bacteria. This is not true. Decay of food materials can be prevented by boiling or by storing it in the refrigerator. Food materials can be stored by dehydrating them, for e.g., peas or by adding chemicals called preservatives. Excess of salt in pickles and sugar in sweets also checks bacterial growth. Raw vegetables and meat can be preserved over a length of time at a low temperature and pressure.

A wound may be cleaned with alcohol to kill the bacteria present on the skin. Surgical instruments are boiled and disinfected with chemicals. Water supplied to our houses is treated with chlorine to make it microbe-free. Milk and its products are prevented from spoiling by a procedure-given by Louis Pasteur. Bacterial diseases can be cured with chemicals called **antibiotics** produced by other microorganisms. However these antibiotics may destroy useful bacteria in our systems and produce resistant bacteria, if not taken in proper doses.

Till now we were discussing only the harmful effects of bacteria. But they can be useful too. Lactic acid bacteria helps to curdle milk and certain bacteria help in the formation of cheese. You already know about the nitrogen fixing bacteria found in the root nodules of pea plants. Secretion of some bacteria are used as antibiotics, for e.g., bacitracin which is isolated from an infected wound.

Today bacteria can be used to prevent pollution of sea water. A bacteria has been discovered which can eat petrol. This would be a novel way to reduce pollution of the sea by oil.

3.2 Virus

These microorganisms are smaller than bacteria and can live only in living cells of plants

or animals. Outside the host cell they act like nonliving compounds and can be crystallised and stored in bottles. They do not have a cellular structure. They have a protein coat surrounding a DNA strand, Fig. 3.3. They attach themselves to the host cells by their tails and then push the DNA strand into the host cells. Then the virus DNA completely takes over the host cell and a large number of viruses are produced within the host cells. This is how the virus affects the host body and causes diseases. They cause common cold, influenza, measles, etc., in human beings.

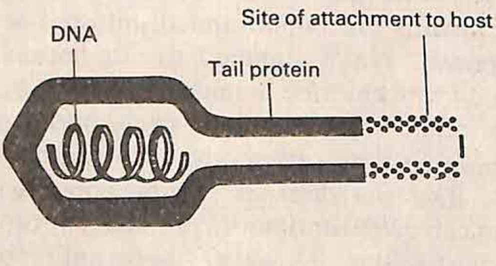


Fig. 3.3 The virus cell.

Tobacco mosaic virus was known as early as 1800. It attacks the leaves of the tobacco plants causing them to wither. By 1900 it had been discovered that many diseases were caused by "living fluid infectants." Though viruses were being studied since 1800 they were isolated and observed under an electron microscope only in 1935. But much before all this was known about viruses, Edward Jenner (1749–1823) gave an effective means of fighting the viral disease smallpox.

Jenner's cure was based on his observations that milkmaids who suffered from cowpox once seldom contracted smallpox. This led him to reason that probably the cowpox infection helped the patient to resist smallpox. To confirm this he injected a young boy with the pus from cowpox blisters, the child suffered from a mild attack of the disease. When the boy was injected with smallpox pus he did not contract the disease.

Later it was learnt that the immunity to smallpox was due to the **antibodies** produced in the patient's body in reaction to the cowpox virus. Such a chemical which causes the body to produce its own antibodies is known as **vaccine**. Today vaccines are used to combat with polio, tetanus, typhoid, tuberculosis, etc., though some viral infections are still to be conquered.

3.3 Algae

The earlier aquatic plants were **algae**, Fig. 3.4. These are unicellular plants growing in water and moist surfaces, such as rocks, wet soil, etc. The algal cells contain pigments which give them the different colours.

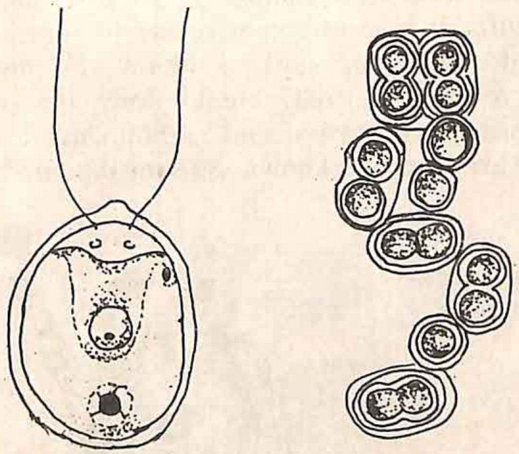
Activity 1: Ask your teacher to take you to the zoo. Observe the pond near the entrance of the zoo. You will see slimy green ribbons floating in the water in the lake. Collect some of these and observe under a microscope. You will find that each ribbon or filament consists of a single row of cells placed end to end, Fig. 3.4(a). Inside each cylindrical cell you can observe one or two strap-like spirals. These spirals help the algae to prepare food.

Spirogyra

Fig. 3.4 (a)

Spirogyra is a filamentous green algae found floating in water, Fig. 3.4 (a). Abundance of these filaments during spring and rainy season impart a bright green colour to lakes and ponds. The *blue-green* algae are considered to be one of the most primitive forms of life. These are unicellular algae existing in colonies some are filamentous while others consist of masses of slimy material in which cells are embedded. They are found in practically every ditch, pond and stream.

The water in the red sea looks red because of the red algae growing in it. Cells of algae contain chlorophyll pigments in bodies called chloroplasts. The algal cells can synthesise their own food by absorbing carbon dioxide and water from their surroundings, just as flowering plants do. They carry on all the life activities and are independent organisms.



(b)
Fig. 3.4 Examples of some algae.

Reproduction in these primitive organisms was very simple and they still reproduce in the same way. One cell divides into two and soon the cells form two independent algae. They may be unicellular, such as **chlamydomonas** or may form filaments and colonies, Fig. 3.4(b). Some cells after dividing do not separate and cling to each other forming irregular colonies or long ribbons. The brown and red algae growing on the ground or on rocks in the sea form large colonies of sea weeds. Chlamydomonas has an independent existence and moves with the help of flagella.

Economic Importance

In water algae are the chief source of food for lower animals and fishes. Whales also exist primarily on algae. It releases oxygen into the water which is essential for aquatic animals and plants. Agar-agar is produced from red algae and from this gelatine powder is prepared. Gelatine is used as a medium for the culture of certain microorganisms, such as bacteria and fungi. It is also used in the preparation of icecreams, fruit jellies, etc.

Sea weeds are used as food in China and Japan. They can be used as fertilisers as well. Some algae can fix atmospheric nitrogen and others contain iodine in good measures. This iodine is essential for human beings for proper growth. Algae is useful to us in so many ways when it is living but when it dies its decomposition pollutes the water and makes it unfit for aquatic beings.

3.4 Fungi

These are microscopic, thread-like structures growing in a colony. They lack true root, stem and leaves like algae but are different from them in that, they lack chlorophyll as well and therefore cannot produce their own food. They depend upon other living organisms or on dead plants and animals for their food. The fungi depending on living organisms are parasites while those feeding on dead organic matter are **saprophytes**. The parasitic fungi are known to cause several skin diseases in man, for e.g., ringworm.

Fungi such as yeast and mucor spoil cooked as well as uncooked food. Fungal diseases cause extensive damage to our crops, for e.g.,

rust in wheat, redrot in sugarcane and they affect the poultry birds and cattle too. The mass of threads of fungi is known as **mycelium** while each thread-like structure is called a **hypha**. The hyphae secrete chemicals which digest the organic matter in plant and animal tissues and this digested food is used by the fungi for growth.

Activity 2: Keep a slice of fresh moist bread in a warm place. Observe it after 2 or 3 days. You will find a white cottony growth on the bread. Observe the growth with the help of a hand lens. These thread-like structures are fungal hyphae. These secrete enzymes to dissolve the bread and absorb the same for growth. This is *Rhizopus*, the bread mould, Fig. 3.5(a). Keep the bread moist for another 4 to 5 days till black spots appear.

Each black spot is a sporecase or **sporangium** produced at the tip of some hyphae. At maturity the sporangia break releasing millions of tiny microscopic spores present in it. Each spore may form a new mould if the conditions are favourable, i.e., water, food and appropriate temperature is available. This is an asexual mode of reproduction.

Penicillium and *aspergillus* form powdery growths on oranges, lemon and other citrus fruits. The blue-green mould penicillium is used in the processing of some varieties of flavoured cheese. The antibiotic penicillin is a secretion of the fungus penicillium, Fig. 3.5(b). It is formed during the normal digestive activity of the mould. This was discovered accidently by Alexander Fleming. He was working on a culture of bacteria when he found it contaminated with a fungus. Wherever this fungus grew its secretions killed the bacteria. As the secretions killed another living organism it came to be known as antibiotic.

Yeast is a well known unicellular fungi, Fig. 3.6(a) It multiplies rapidly if kept in a starch or sugar solution at a warm temperature. It is used commercially for producing alcohol from sugar solution. During its growth it partially breaks down the sugar, producing alcohol and carbon dioxide gas. This process is known as **fermentation**. Yeast

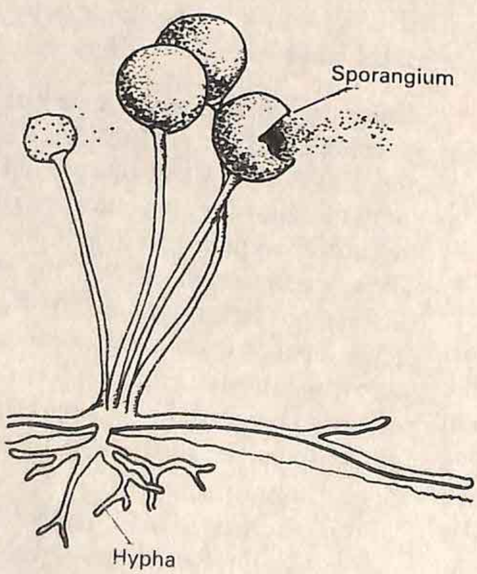


Fig. 3.5 (a) Rhizopus, the bread mould.

Fig. 3.5 (b) Penicillium

is also utilised in bakeries to make the bread and cakes fluffy.

Mushrooms

Mushrooms are the largest amongst the different varieties of fungi. They are generally found growing in warm and moist woods, gardens, orchards, fields, etc. The mushroom seen above the ground is the reproductive structure and represents only a portion of the complete mushroom plant, Fig. 3.6(b). The vegetative part consists of a tangled mass of colourless hyphae beneath the soil.

The hyphae secrete chemicals to breakdown the source of food into simple molecules, and absorb them through their cell walls. Each mushroom produces millions of microscopic spores which are carried away by the wind. A number of them may die while others may fall on a favourable spot and grow into new mushrooms.

Only a few mushrooms are edible. Rest are very poisonous and if eaten may even prove fatal. Only specialists can distinguish edible mushrooms from poisonous ones.

3.5 Lichens

Lichens can grow in completely shaded areas on the forest floor and even on bare rocks. In fact in the cold Siberian plains these are the only forms of vegetation. Popularly known as 'reinder moss', they form the diet of reindeers. Lichens are also found growing in thin layers or patches on old buildings, tree trunks and dead trees. They are of different types. They may be in the form of strands or branches or may form leaf-like lobes. Some are also found as thin crusts, Fig. 3.7.

Activity 3: Scrape a greenish layer from a damp crevice and observe it with a hand lens. You will find some colourless threads, all entangled. In between this entangled mass there are some green coloured cells. The threads are the hyphae of fungi trapping the green algal cells, Fig. 3.8. What could be the reason for this association? The green algal cells are capable of preparing their own food provided they have sunlight and water.

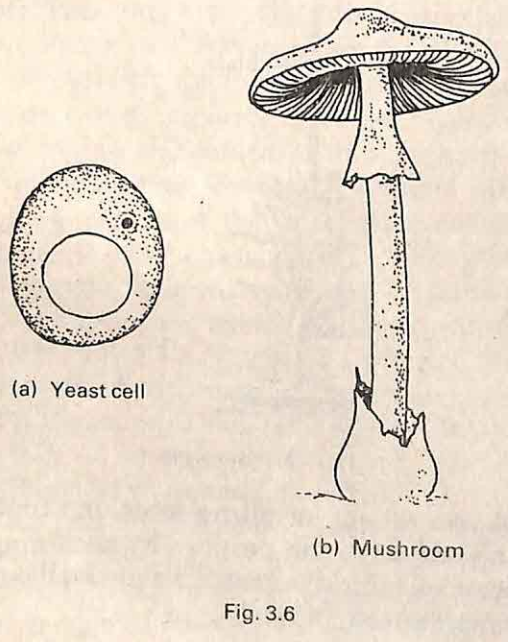


Fig. 3.6

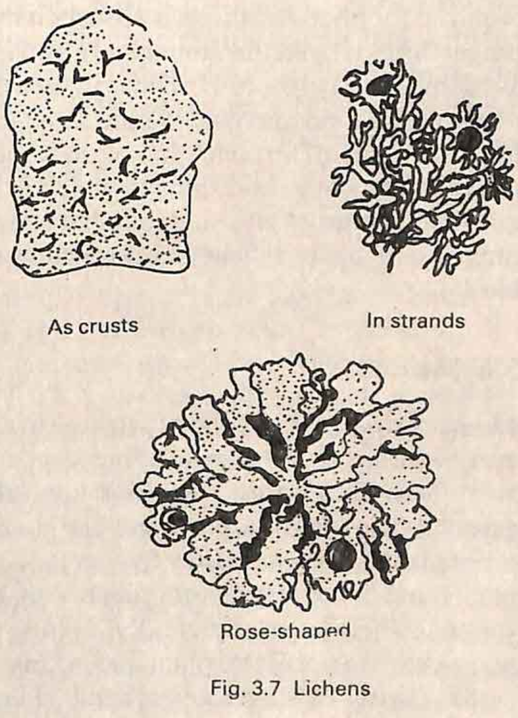


Fig. 3.7 Lichens

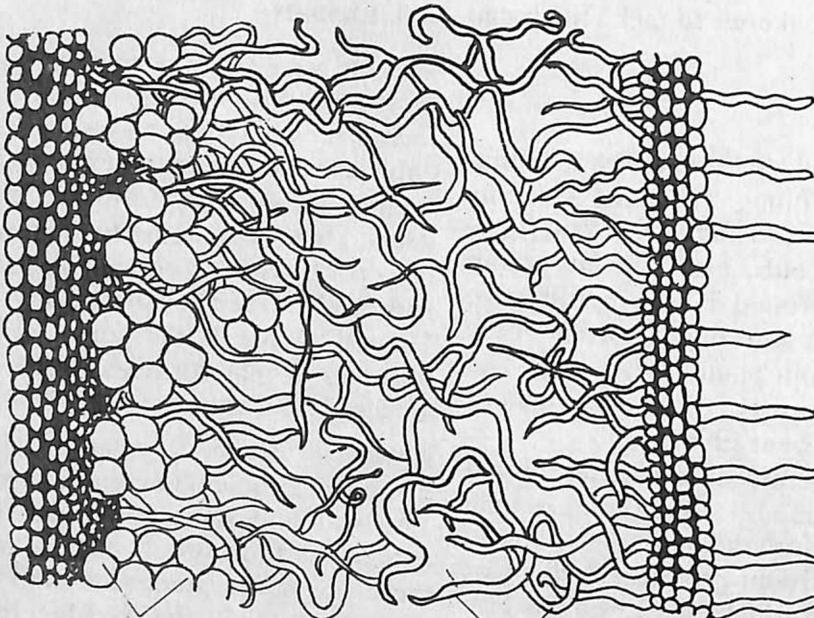


Fig. 3.8 Symbiosis in lichens

The algae in lichens are placed such that they are exposed to sunlight. The water required for photosynthesis is absorbed by the fungal threads from the atmosphere and made available to the algal cells. These in turn manufacture the food and provide the same to the fungal hyphae. Thus each helps the other to thrive in the hard conditions in which lichens grow. This mutual give and take between the fungus and algae of lichens is known as **symbiosis**.

3.6 Mosses

Mosses are small land plants growing in shady and moist ground under the trees, on rocks, and also on old walls. They look like tufts of carpet but actually are a compact clump of moss plants. Although they live on land these plants have no structures which can carry water to their leaves efficiently. Hence these plants are small. Each plant has a tiny stem with a cluster of leaves encircling it, Fig. 3.9.

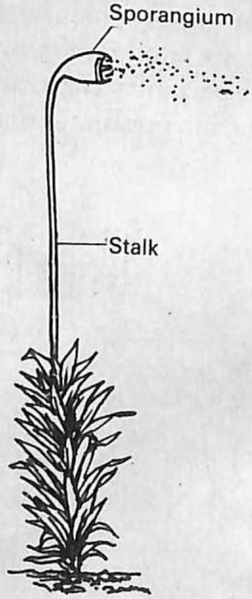


Fig. 3.9 A moss plant.

Mosses do not have true roots, but root-like **rhizoids** serve the purpose by anchoring the plant and absorbing some water and dissolved minerals from the soil.

The tiny leaves absorb water directly from the environment as well. They never bear flowers but produce spores for reproduction. The swollen structures at the tip of each stalk burst open to release the spores in it. These may develop into new plants under favourable conditions. At one time, millions of years ago, mosses were probably one of the most common forms of plant life on earth. Their importance today is not so much due to their own presence but due to the remains of their ancient relations. The ancient green plants stored solar energy in their leaves. When they got buried under the earth they got converted to coal or oil over the years, under the high pressure exerted by the layers of earth. Thus solar energy became stored as chemical energy.

Mosses together with lichens serve as soil builders. Wherever they grow on rocks they gradually wear them down by their acid secretions and make soil layers for the new plants to grow on.

3.7 Ferns

Ferns were the first plants to possess true roots, stems and leaves. Also they possess special channels for the conduction of water and dissolved minerals from the roots to leaves and food from leaves to other parts of the plants. Ferns have a horizontal stem creeping just below the soil surface called a **rhizome**. It bears clusters of true roots growing into the soil while delicate compound leaves known as **fronds** grow above the ground, Fig. 3.10. The leaves prepare food for the plant and bear spores on the underside for reproduction. These spores grow into new plants.

Millions of years ago ferns were not limited to a few places in the woods, swamps, hillsides or pots. They formed large forests which covered the then common marshy lands. Fern trees as high as 30–40 ft were also abundant.

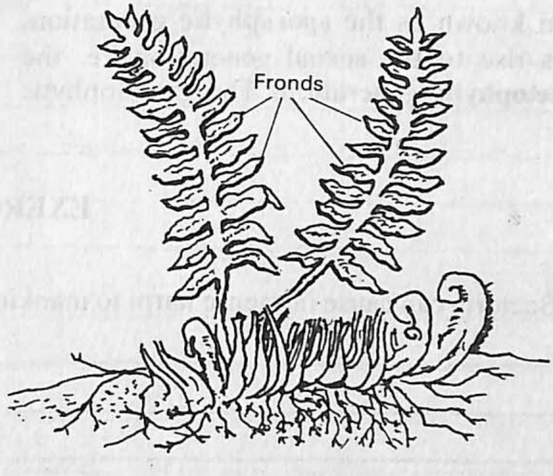


Fig. 3.10 Fern plant

During that period, known as **carboniferous** period, great layers of ferns got buried in the swampy areas where they grew. Later the movements of the earth compressed these layers into layers of coal. 300 ft. of compressed vegetation formed 20 ft of coal.

Today ferns are grown as ornamental plants. The beautiful Maiden hair fern has leaf stalks resembling the black locks of a maiden. The other fern commonly seen in gardens and nurseries is *Pteris*, with soft and green curling fronds.

Alternation of Generation

Plants can reproduce sexually as well as asexually. The trees which bear flowers and fruits, produce seeds as well, i.e, they reproduce sexually. Certain lower plants such as bacteria reproduce asexually by undergoing fission after a certain period of growth. You already know that mosses and ferns reproduce by means of spores. This is also an asexual mode of reproduction. However these plants can reproduce sexually as well by producing gametes, i.e, the male and female sex cells. In fact there is an **alternation** between the asexual and sexual generation. The asexual gener-

ation known as the **sporophytic** generation, gives rise to the sexual generation, i.e. the **gametophytic** generation. The gametophytic generation in turn gives rise to the sporophytic generation, hence the name alternation of generation.

EXERCISES

1. Bacteria can cause immense harm to mankind. Justify the statement.

2. Give a short account of the usefulness of bacteria.

3. How do viruses differ from bacteria?

4. What is the economic importance of algae?

5. Who discovered penicillin and how?

6. Describe the commercial use of yeast.

7. (a) What is the role of the hyphae in fungi?

(b) There is a mutual give and take relationship between the fungal and algal cells of lichens. Explain.

8. How do the mosses owe their importance to their ancient relations?

9. Fill in the blanks.
   (a) Milk and its products can be prevented from spoiling by a process known as ______.
   (b) ________ ________ observed that the ________ infection helped the patient to resist ________.
   (c) A chemical which causes the animal body to produce its own antibodies is known as ________.
   (d) ________ are fungi feeding on dead organic matter.
   (e) Mosses have ________ which anchor these to the soil.
   (f) The horizontal stem in ferns is called a ________.
   (g) Ferns have delicate compound leaves known as ________.
   (h) In the ________ period the ferns got buried in the swamps where the grew.

4

The Root : An Organ for Absorption

Flowering plants have different organs for absorption, conduction and photosynthesis. They are differentiated into root, stem, and leaves. They bear flowers for reproduction. In this chapter we will be studying about the root. Root is the descending organ of a plant and grows into the soil. Roots are specialised organs for the anchorage of plants to the soil. They are responsible for the absorption of water and minerals from the soil and conduction of the same to the stem, leaves, etc. In addition to these primary functions, roots of some plants get modified to carry on other special functions such as storage of food, respiration, vegetative reproduction of the plants, etc.

4.1 Soil Composition

Soil is essential for the growth of plants. The roots fix the plant to the soil and absorb moisture and the necessary minerals from it. Thus the soil plays a key role in the growth of plants. It is the upper loose layers of the earth's crust which we call **soil**. This layer must be porous to allow air into its layers and must be soft so as not to damage the tender roots. You may have seen a farmer plough his fields in order to loosen the soil and allow air into the layers.

Soil consists of four components which vary in proportions to produce different types of soils. Let us find out about the composition of soil.

Activity 1: Get a beaker from your chemistry laboratory and fill it with distilled water. Bring in a handful of soil from your school compound and stir it into the beaker of water. The soil should be completely covered with water. Keep it aside for a while. Do you observe different layers separating out from the soil?

The largest and the heaviest particles settle at the bottom, Fig. 4.1. They comprise the **gravel**. This layer is covered by a layer of **sand**, which is followed by a layer of fine particles forming **silt**. Silt is covered with an even finer layer of particles of **clay**. Above this is a column of water, and decaying animal and plant matter called **humus** floats on it. It is this humus in the top soil which increases the soil fertility. The percentage of the different components vary to produce different types of soils.

When the soil is more than 50 percent sand

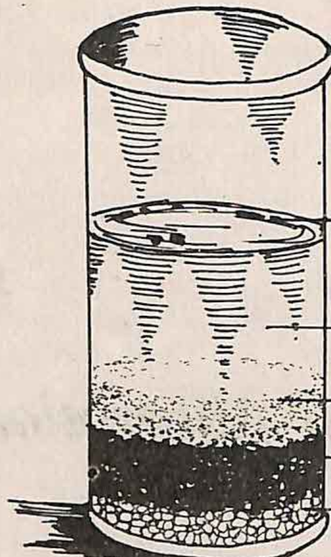


Fig. 4.1 Components of soil

we have **sandy** soil while more than 50 percent of clay makes the soil **clayey**. A third kind of soil contains clay, gravel and sand in good measures. It also contains the organic layer, humus. This kind of soil is known as **loam**. It is the best soil for proper growth of plants as it contains sufficient air, water and mineral salts.

Thus the soil meets all the requirements of a plant. The roots absorb the minerals dissolved in water and utilise the air present in it. You could conduct a simple experiment to verify that soil contains air and water, with mineral salts dissolved in it.

Activity 2: Take three test tubes, fill them to a quarter with soil from your garden. Label them as 1,2 and 3. To one test tube add water along the sides such that it stands well above the layer of soil.

After sometime you will observe bubbles in it. Water occupies the space between the soil particles and displaces the air in it. This shows that there are air spaces in the soil. To the second test tube add distilled water. Filter the water in a china dish and evaporate it over a burner. You will find some crystals of salt left behind. These are the crystals of the mineral salts present in the soil. Now can you tell why we used distilled water instead of tap water?

Next hold the third test tube over a burner. What do you observe? The droplets of water on the cooler parts of the test tube indicate that soil contains water. It is this water which moves up through the narrow channels called **capillaries**, formed between the soil particles and is available to the roots. The water is said to move upwards by **capillary action**. So now you know how the plants depend on the soil for their very existence. There are different types of roots which bind the plants to the soil. Let us study about them.

4.2 The Root, its Structure and Types

There are different kinds of roots and each type has its own structure related to its functions. For example, grass, maize, rice and wheat have a **fibrous** root system, i.e., they have a bunch of fine roots arising from the base of the stem, Fig. 4.2(a). These roots do not penetrate deep into the soil and are thus ideal for absorption of water and minerals from the rich top soil.

On the other hand **tap roots** grow deep into the soil to obtain water from the lower layers. They are characteristic of plants such as pea, bean, gram, etc. The tap root arises as a thick branch at the base of the stem and gradually tapers as it moves down into the soil, Fig. 4.2 (b). It bears many branch roots. These branch roots fix the plant to the soil and also absorb water and mineral salts from it.

The root has various regions and tissues which carry on their specific functions, Fig. 4.3(a). Roots of the seedlings (newly germinated seeds) show a white fuzzy growth extending from the surface of the root at a short distance from the root tip. These are the

Fig. 4.2 (a) Fibrous root system of common grass

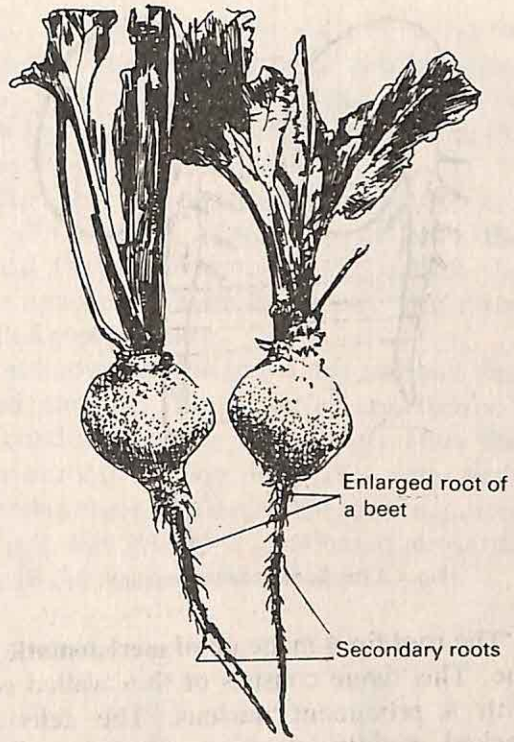


Fig. 4.2 (b) Tap root of beet.

tiny **root hairs** and are very important in absorbing water and the minerals dissolved in it. Root hairs require oxygen for respiration, hence they grow in the soil containing plenty of both air and water. So while transplanting a plant a large amount of soil around the roots should be kept infact. Otherwise root hairs may get damaged and the plants will then die.

The tip of the root is covered by a root **cap.** This protects the delicate tip from being damaged by the coarse particles of soil. As the root grows down into the soil new root hairs are formed close to the tip and the older ones wither away. Just above the root cap but below the region of root hairs there is a **zone of elongation,** Fig. 4.3 (b). This region shows maximum growth. Hence it is this region of the root which keeps on growing and forms new root hairs.

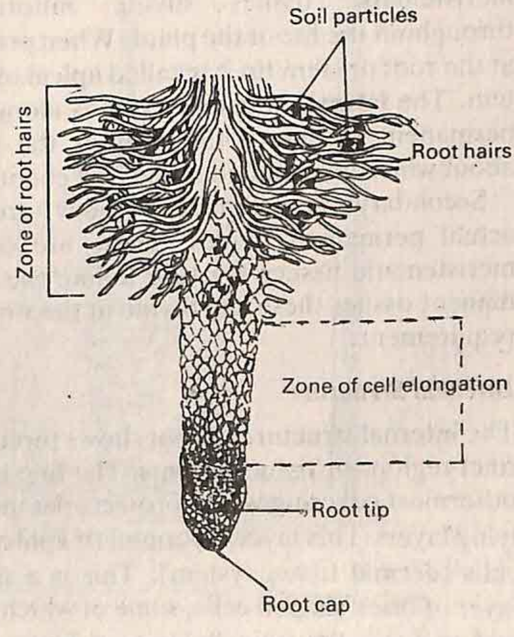


Fig. 4.3 (a) Regions of the root.

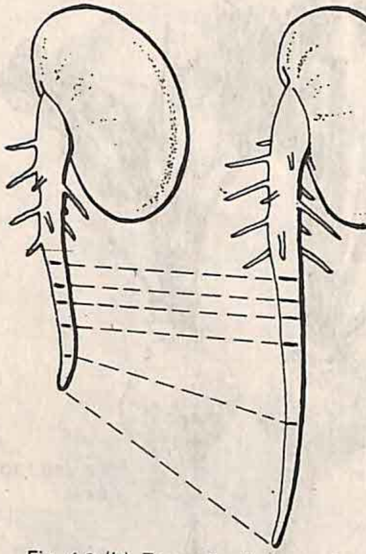


Fig. 4.3 (b) Zone of cell elongation.

The root tip is made up of **meristematic** tissue. This tissue consists of thin walled cells with a prominent nucleus. The cells are packed tightly, leaving no intercellular spaces. There are two types of meristematic tissues—**primary** and **secondary.** Primary meristematic tissues divide mitotically throughout the life of the plant. When present at the root or stem tip it is called **apical** meristem. The **lateral** meristem extends along the permanent tissues of the root or the stem about which you studied in the first chapter.

Secondary meristematic tissues are in actual permanent tissues. These are called meristematic tissues because unlike the permanent tissues these can divide at the time of requirement.

Internal Structure

The internal structure of root shows three distinct regions or tissue systems. The first is the outermost covering which protects the underlying layers. This layer is formed of **epidermal** cells (**dermal** tissue system). This is a single layer of brick shaped cells, some of which project to form the unicellular root hairs. The epidermal layer is present only in younger parts of roots some two to three mm behind the apex.

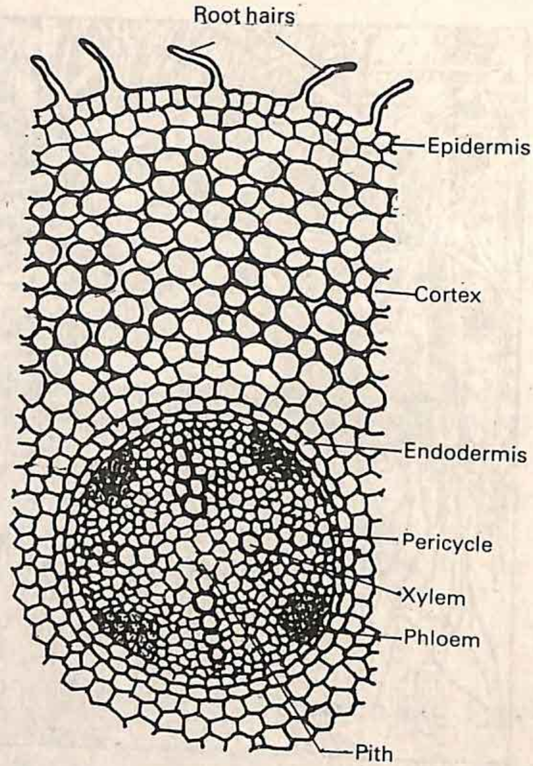


Fig. 4.4 Internal structure of root of bean plant.

The second layer is in between the epidermal layer and the central core of **vascular** tissues. It is formed of parenchymatous cells with intercellular spaces, Fig. 4.4. This layer is known as **cortex.** This is the principal storage area of the root and in general these cells are larger compared to the epidermal cells. As the roots grow old and increase in girth, the epidermal layer ruptures and exposes the outer layer of cortex.

The vascular tissues are enclosed within a single layer of closely packed cells called **endodermis.** There is another single layer of thin-walled cells lying within the endodermis called **pericycle,** Fig. 4.4. The central cylinder of vascular tissues is the principal conducting and strengthening region of the root. It is composed of the **xylem** and **phloem** tissues and may contain **pith** as well.

It is through xylem that water and the minerals dissolved in it travel upward to the stem and leaves. Hence it is the water conducting tissue. Phloem is the food conducting tissue and lies outside the xylem. **Secondary** roots i.e., new branches of roots arise from the vascular cylinder.

4.3 Absorption of Water by Roots

Slender and flexible root hairs penetrate through the soil particles and absorb water from the intervening spaces. Their great number increases the surface area over which absorption can take place. A considerable amount of water is also absorbed beyond the root hair zone, towards the apex of the root. Only living cells can absorb water and not the dead ones.

From the root hairs water passes through the cortex to the vascular tissues, i.e., to the xylem in the centre of the root.

Activity 3: Choose a carrot with a large top and scoop out a cavity of about 2 cm., at the top. Prepare a concentrated sugar solution and fill the cavity. Take a cork and bore a hole through it. Pass a glass tube through the cork and fix it into the cavity. Apply molten wax along the cork to make the apparatus air tight.

Mark the level of sugar solution in the tube. Fix the carrot in a beaker containing water, as shown in Fig. 4.5. Keep the beaker aside for 30 minutes. What do you observe? The level of solution in the tube has risen. This shows that the carrot has absorbed water from the beaker. This experiment can be used to understand the process of absorption in roots.

The water with mineral salts dissolved in it enters the root hairs through the membrane of its cells. This process of movement of a liquid across a membrane is known as **osmosis.** The water travels from the root hairs to the cortex and from there to the central core of vascular tissues. The xylem cells of the root are in line with those of the stem. So the water entering the central core is transported to the stem from the root by the xylem cells. From the stem the water is transported to the leaves.

When the water travels from cell to cell through the cortex, a force is developed in the cortical tissues of roots which pushes the water upwards through the xylem. This force is called **root pressure.**

You know that the soil water contains dissolved minerals. These minerals are absorbed and conducted along with water. Thus the water in roots is never pure. This water with minerals dissolved in it is called as **cell sap.** It is this cell sap which is conducted upwards through the root towards the stem.

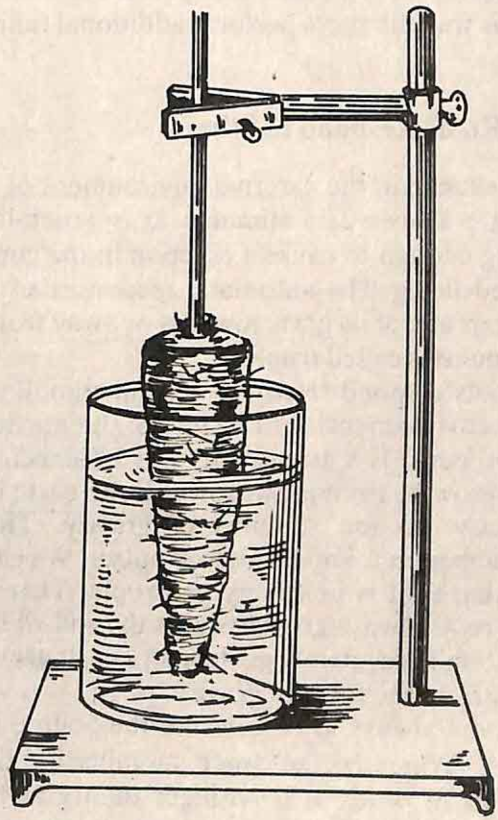


Fig. 4.5. Absorption of water in roots.

Activity 4: Take a potted plant and water it well. Cut the stem near the soil. The cut end of the stem will exude plenty of cell sap showing that there is a force in the roots which pushes the cell sap up to the stem from the roots. This is the root pressure and can be observed only in living roots.

In addition to the primary function, roots get modified to carry out special functions. The roots which serve as storage organs become fleshy. They have plenty of storage parenchyma tissues, i.e., cortex. Examples of this type of roots are carrot, radish, etc. In your earlier class you have read about **prop** roots of Banyan trees which support its heavy branches. In marshy areas the soil has little or no air in it. The **breathing** roots of trees such as *Rhizophora* come out of the soil to take in air through the pores present in them. In this way the roots perform additional functions.

4.4 Roots Respond to Stimuli

Any change in the external environment of a being is known as a **stimulus.** It is generally strong enough to cause a reaction in the concerned being. The automatic responses of a plant or any of its parts towards or away from a stimulus is called **tropism.**

Roots respond slowly to certain stimuli in their environments. For example, the gravity of the earth is a strong stimulus influencing root growth. Root grows towards the earth in response to the stimulus of gravity. This phenomenon is known as **geotropism.** We can say that root is positively geotropic. That is why roots always grow towards the soil while the stem is negatively geotropic, i.e., it grows away from the force of gravity.

Roots always grow towards the source of water. Water is the other stimulus for the growth of roots. It is stronger than gravity. This response of roots towards water is known as **hydrotropism.** That is why fibrous roots spread out through the moist top soil and tap roots grow deep in the soil to get water from the layers of the soil.

Activity 5: Take a few bean seeds and place them in different positions in a flower pot, as shown in Fig. 4.6. Cover them up with soil. Water the pot regularly. After 2–3 days you will observe that the primary root turns at an angle of about 90° and grows downwards, irrespective of its position. On the other hand the stem turns at a similar angle and grows upwards, Fig. 4.6. The stem however grows in response to the stimulus of light as well.

Activity 6: Take a basket made of coir netting

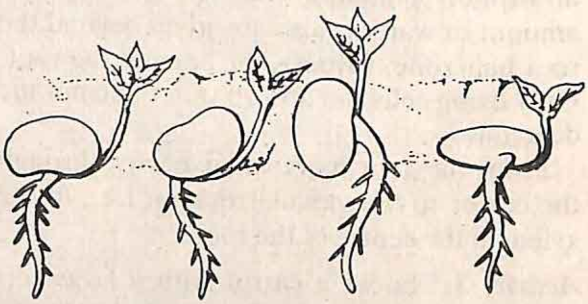


Fig. 4.6 Response of root and stem to the stimulus of gravity.

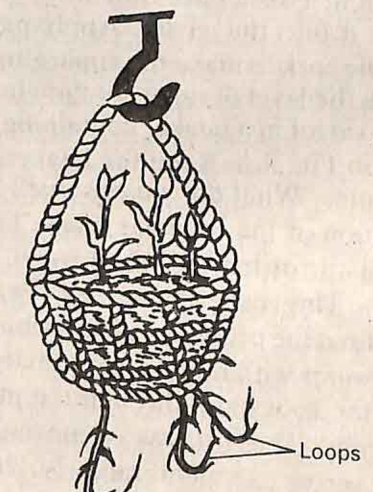


Fig. 4.7 Hydrotropism is stronger than geotropism.

and fill it up with moist sawdust. Place a few soaked seeds on the sawdust. Hang the basket from a hook so that it is at some height from the ground. You will observe that the roots initially grow downwards in response to gravity and come out of the basket. But they soon turn back towards the moist sawdust and enter the basket forming loops, Fig. 4.7. This shows that the stimulus of moisture is stronger than the stimulus of gravity.

EXERCISES

1. Draw and label the various components of the soil.

2. How are fibrous roots different from tap roots?

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3. Draw a labelled diagram of the internal structure of a root.

4. The various regions of the root carry out their specific functions. Elaborate.

5. Explain the function of the two types of meristematic tissue.

6. How does the water travel from the soil upto the different parts of the plant ?

7. Explain the terms:

(i) Geotropism:

(ii) Hydrotropism:

8. List the functions carried out by the root, other than absorption. ____________________

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9. Match the following:

(i) Osmosis	(a) protects the root tip.
(ii) Rhizophora	(b) has breathing roots.
(iii) Stimulus	(c) movement of liquid across a membrane.
(iv) Root cap	(d) water with mineral salts dissolved in it.
(v) Cortex	(e) change in external environment.
(vi) Cell sap	(f) principal storage region of root.

5

Stem, Its Structure and Functions

The stem of a plant plays two major roles, both of which are very important for the survival of the plant. It provides support for the leaves and branches and is responsible for the production and display of leaves and flowers. The branching system of a stem and the arrangement of leaves are such that they receive sufficient light for photosynthesis. The green stems of opuntia can synthesize food as well.

Conduction is the chief activity of the stem. Stems act like conducting pipe lines through which water with dissolved minerals ascend upwards towards branches, leaves and fruits. Synthesized food materials travel from leaves through another set of pipe lines, towards growing points, roots and storage organs.

In certain plants stems get modified to carry on special functions, for e.g., storage of food and vegetative reproduction. When a part of a plant other than the flower starts reproducing a new plant of its own kind, it is known as **vegetative reproduction**. Here the new plants produced through vegetative reproduction are identical to the parent plants. Stems are more often involved in vegetative reproduction than roots and leaves.

Potato, ginger and onion are stems which store food and can reproduce vegetatively. In other words no fusion of the sperm and egg cell occurs in such a reproduction. The new plant develops solely by cell division from plant parts, stem in this case.

Rhizomes are modified stems which carry on the function of storage of food. Survival of the plant through unfavourable conditions, i.e., **perennation** is another function carried out by the rhizome. It remains under the soil till the weather is favourable. Then the buds on the rhizome give out new shoots and in this way year after year it produces new plants. Ginger and turmeric are examples of rhizomes.

Grasses keep growing and spreading by means of their runners. Suckers of the chrysanthemum plant produce new plants. Potato reproduces vegetatively from its buds. Let us carry out an activity to see how the potato reproduces.

Activity 1: You must have noticed the black spots on potatoes. These are the buds and are called 'eyes.' Cut the potato into pieces such that each piece retains an eye. Place these pieces in a pot and fill it up with moist saw dust. After a few days you will observe a small

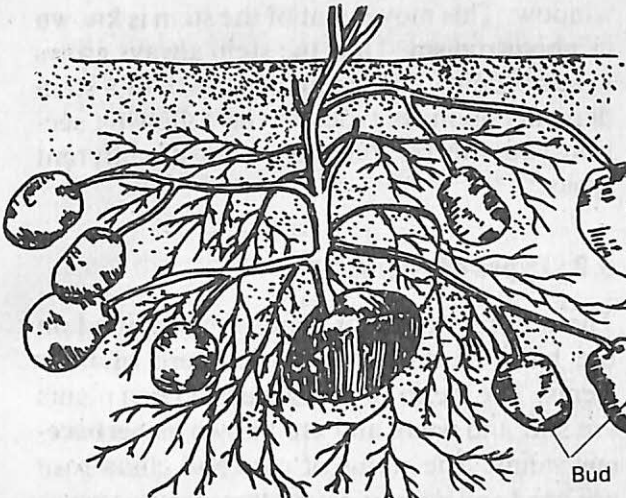

Fig. 5.1 Vegetative propagation in potato

shoot with tiny leaves growing out of each eye, Fig. 5.1. Thus each eye or bud is capable of producing a new plant vegetatively.

5.1 Development of the Stem

The embryo present in the seed encloses the **plumule**, the young shoot. This grows to become a stem bearing leaves, branches and flowers. The apical or terminal bud at the tip of the stem has a cluster of delicate young leaves, Fig. 5.2. It is actually a reduced stem and it keeps the tip of the stem ever young and growing.

The axils of leaves have buds which give rise to lateral branches while the tips of leafy shoots bear buds which form the flower. The stem bears flowers so that they get displayed properly. In this way insects are attracted to the flowers for nectar and in the process pollinate them. The region below the apical bud is the zone of elongation in stems. The cells in this region undergo repeated divisions and add to the length of the plant, Fig. 5.3.

The points of attachment of the leaf to the stem is called a **node** and the distance between two nodes is called an **internode**. The stem

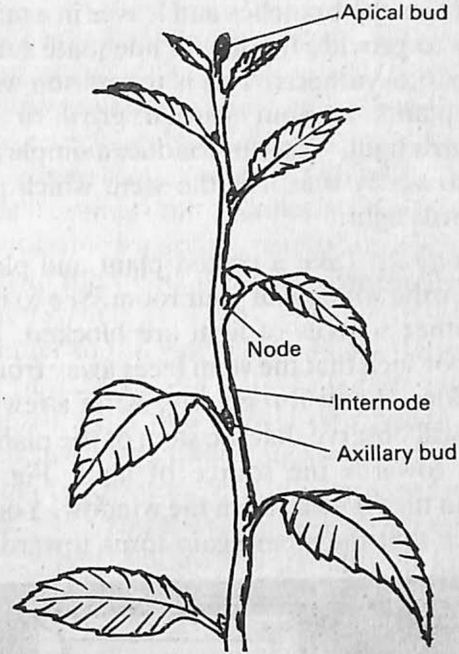

Fig. 5.2 Parts of a stem.

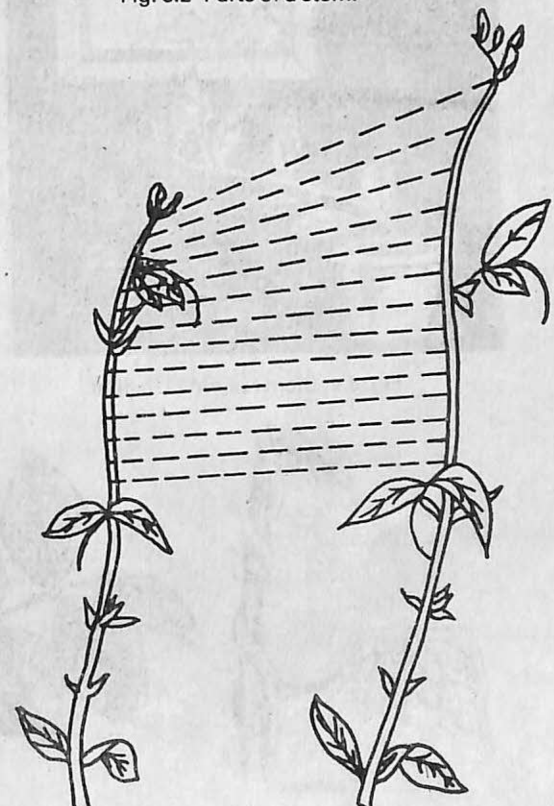

Fig. 5.3 Zone of elongation in stems.

produces the branches and leaves in a manner so as to provide them with adequate sunlight for photosynthesis. This is the reason why all the plants in your garden grow or bend towards light. You can conduct a simple activity to verify that it is the stem which grows towards light.

Activity 2: Take a potted plant and place it under the window of your room. See to it that all other sources of light are blocked. Place the pot such that the stem faces away from the window. Water it regularly. After a few days you will observe that the stem of the plant has bent towards the source of light, Fig. 5.4. Again turn it away from the window. You will notice that the stem again turns towards the window. This movement of the stem is known as **phototropism**. Thus the stem always grows towards light. The extent of growth of a stem depends upon its type. In the following section you will be studying about its different types.

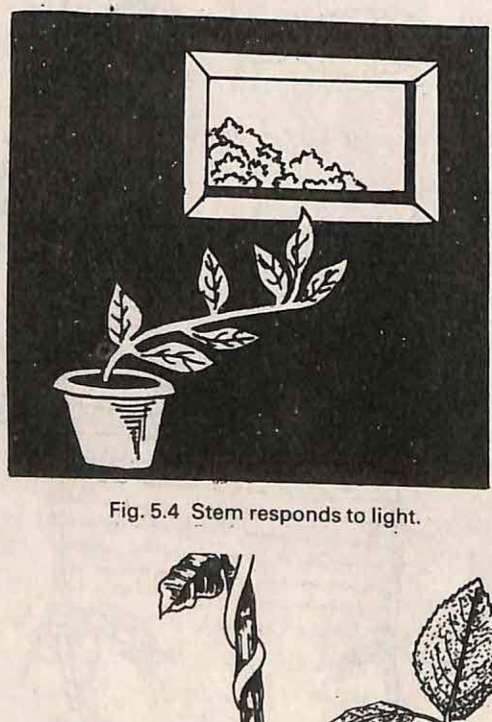

Fig. 5.4 Stem responds to light.

5.2 Types of Stems

The different types of plants are classified on the basis of the external structure of their stems. The stems of sunflower and pea plants are soft and weak and are known as **herbaceous** stems. The stems of rose and china rose are hard and woody. Such stems are known as **woody** stems. Over and above being hard and woody if the stem is short and bushy as well, the plant is called a **shrub**. On the other hand a tree has a tall woody stem called a trunk and bears branches at a height from the ground.

Among the weak stems some grow horizontally along the ground, for e.g., water melon. Stems of mint and grass grow along the ground and strike roots at the nodes to remain fixed to the ground. This is the reason why it is difficult to pull out a clump of grass. These are examples of **creepers**. There are yet other weak stems which coil round a support. The bean plant is one such example of a **twiner**, Fig. 5.5. You must have seen a rose plant growing along the wall. It climbs the wall with the help of curved hooks, just as the pea plant

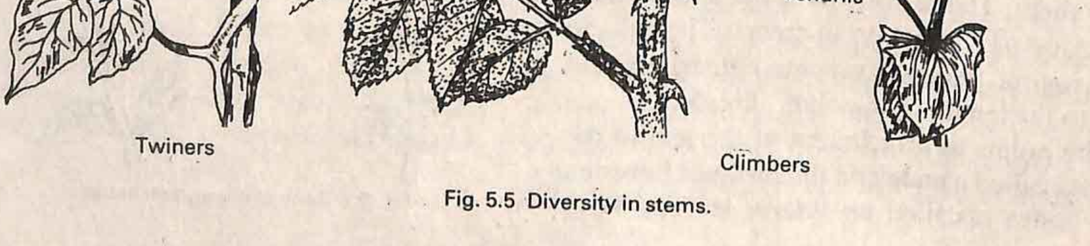

Fig. 5.5 Diversity in stems.

climbs the support by means of spiral structures called **tendrils**, Fig. 5.5. These are the **climbers**.

5.3 Internal Structure of the Stem

Activity 3: Cut a section of a sunflower stem from the region between two nodes. Examine it under the microscope. You will observe **vascular** bundles arranged in a circle. These bundles form a continuous channel through the stem. The vascular bundles consist of closely packed, thin-walled phloem cells on the outer side and hexagonal xylem cells on the inner side, Fig. 5.6. The xylem tissue forms the hard woody region of the stem. This region of living tissues is known as **sapwood**.

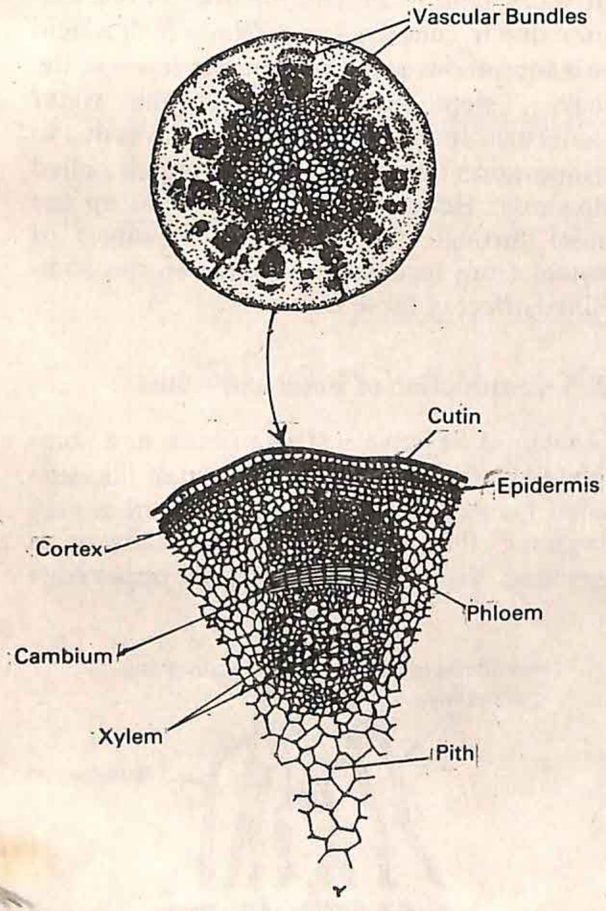

Fig. 5.6 Internal structure of the stem.

As you know the phloem tissue conducts food materials from the leaves to other parts of the plant while the xylem tissue conducts water and dissolved minerals. The xylem and phloem tissues are separated by a thin layer of cells forming the **cambium**. This layer is responsible for adding new xylem and phloem cells to the stem. This increases the thickness of the stem.

Inner to the vascular bundles is a pale region of parenchyma cells, called the **pith**. It is scarcely seen in woody stems but in young branches it occupies a large area and serves as an important storage tissue. In stems lacking a pith, the central region is also occupied by hard wood, known as **heart** wood, Fig. 5.7. The tissues of heartwood are dead and are filled with gum, resins, etc. This tissue gives support to the tree and is used for making furniture.

Outside the ring of vascular bundles are cells which make up the **cortex**. Outer to the cortex is a single layer of cells forming the **epidermis**. This layer protects the underlying tissues from injury and diseases. The epidermis together with the cortex and phloem tissue forms the **bark,** the outermost region of the stem. The phloem tissue forms the **inner** bark. The bark is separated from the woody region, i.e., sap wood and heart wood, by the layer of cambium cells, Fig. 5.7.

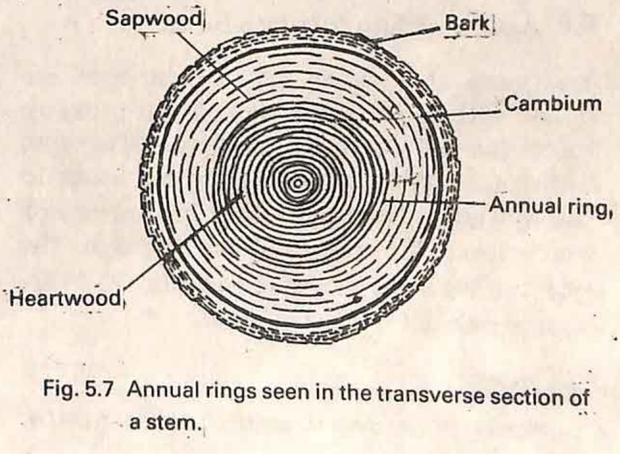

Fig. 5.7 Annual rings seen in the transverse section of a stem.

Growth

Stem grows in length by forming new tissues at its tip or in some cases at the nodes. Growth in length is limited to the actively growing area of the tip and node region. This growing region at the tip of branches and the stem is often several inches long from the tip. Once the stem matures it can no longer increase in length. Growth in diameter results due to the increase in the number of cells of the cambium, located deep in the vascular bundles of the stem.

It adds phloem tissue on its outer surface and xylem tissue on its inner surface thereby increasing the girth of the stem. During its activity more cells of xylem tissues than phloem tissues are produced. That is why wood area of a tree is always much greater than its bark thickness.

In winter or drought periods very few cells are formed by the cambium. They are small in size and have thick walls and they form a dark ring of **autumn** wood. In spring the cambium cells divide rapidly to produce large, thin walled cells. These form a light ring of **spring** wood. These rings are known as **annual rings**. These rings indicate the growth achieved in a particular season. By counting the number of rings present in the stump of a tree we can determine the age of the tree at the time it was cut.

5.4 Ascent of Sap through Stem

You know that xylem cells of the root are in line with those of the stem. Root pressure forces the cell sap into the xylem of the stem with considerable force,causing the water to rise upwards. There are other factors as well which force the ascent of sap through the xylem of the stem. These are capillarity, evaporation pull and cohesive force.

Capillarity

Capillarity is the rise of water level in narrow channels or tubes, above that of the surrounding level. We can illustrate capillarity by placing a small glass tube or a plastic straw in a glass of water. The level of water in the tube will be higher than that in the glass. Water is attracted by the walls of the tube and thus rises above the level in the glass. Vessels and tracheids of xylem act as capillaries of the stem, by drawing water upwards along their walls.

Evaporation pull

Leaves constantly loose water into the air from their surface due to evaporation. This loss of water from the leaves results in an evaporation pull which causes water to rise through the viens of leaves. The molecules of water tend to remain together in one column due to **cohesive** force. Water is thus held in a continuous column through vessels of the leaves, stem and roots. As the water molecules are removed from the leaves due to evaporation the entire water column is pulled upwards. Hence the cell sap moves up the stem, through the continuous channels of xylem from root to leaves,due to the combined effect of these forces.

5.5 Conduction of Food Materials

Activity 4:Remove a strip of bark in a complete ring from the lower portion of the stem of any woody plant, such that only the woody region of the stem remains. This is known as **girdling**. You will observe that the upper edge

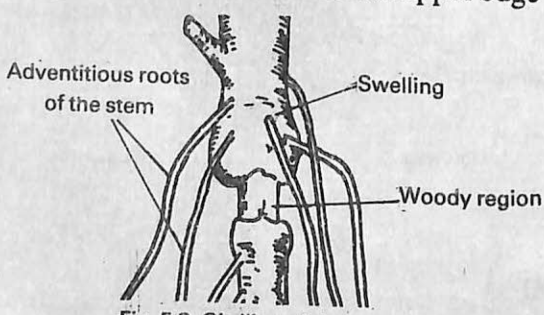

Fig. 5.8 Girdling of the stem.

of the cut strip becomes protuberant and gives out new adventitous roots, Fig. 5.8. The reason is that the food prepared by the leaves is unable to pass below the cut area of the stem to the roots. This is because the phloem tissue of the inner bark has been removed. So the food accumulates above the cut. This shows that the phloem tissue is responsible for the conduction of food materials from the leaves to the other parts of the plant. It is the seive tubes and the companion cells of the phloem tissue which carry out this function.

EXERCISES

1. What is the chief function of a stem?____________________

2. What are the other functions carried out by the stem?____________________

3. Draw a labelled diagram of the different parts of a stem.

4. How can you say that stems exhibit phototropism? ______

5. Differentiate between the following:
   (i) Herbs and shrubs. ______
   (ii) Creepers and twiners. ______
   (iii) Heartwood and sapwood. ______
   (iv) Springwood and autumn wood. ______

6. Draw a diagram of the internal structure of the stem and label its parts.

7. How does capillarity help in the rise of sap along the stem? ____________________

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8. What is the role of evaporation in the ascent of sap? ____________________

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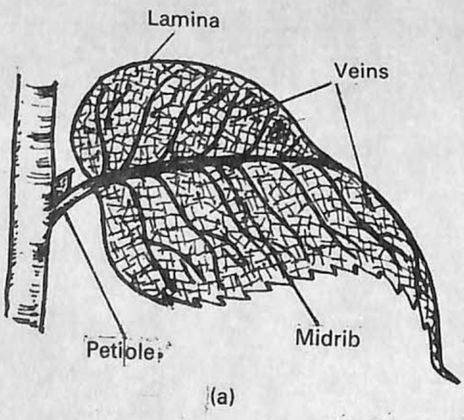
9. Fill in the blanks.

(i) The ____________ is responsible for the increase in girth of a stem. It adds ____________ cells on its inner surface while ____________ cells are added on its outer surface.
(ii) The ____________ of potatoes are nothing but buds which can grow into new plants ____________.
(iii) By counting the number of ____________ the age of a tree can be determined.
(iv) The water molecules stay together in one column due to ____________.

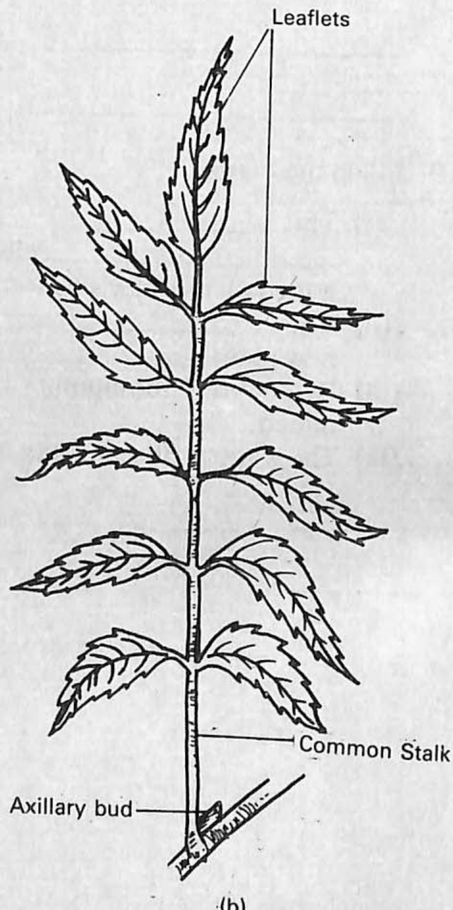
Leaf, Its Structure And Functions

The leaf is the green organ of a plant, arising from a node and bearing axillary bud in its axil, Fig. 6.1(a). It has a **midrib** running through its flat surface called **lamina.** From the midrib arise the veins. It may be a **simple** leaf joined to the stem by a stalk or it may have small leaflets on a common stalk attached to the stem, Fig. 6.1(b).

The leaf is capable of absorbing solar energy and converting it into chemical energy in the form of sugars. This sugar may be stored in stems and roots and provides man and animal with food. The leaves are borne on the stem such that they get maximum sunlight.



(a)



(b)

Fig. 6.1 Simple and Compound leaf

6.1 Arrangement of Leaves

For trapping sunlight the leaves must be properly exposed to it. The stem bears the leaves in a manner so as to provide them with maximum exposure. There are three types of arrangements of leaves. **Alternate** arrangement has a leaf on alternate sides, i.e., the upper leaf is on the opposite side of the lower one, Fig. 6.2(a). In this way each leaf has adequate sunlight.

In **opposite** arrangement there are two leaves at a node, opposite each other as in jasmine, Fig. 6.2(b). In oleander leaves there is **whorled** arrangement with more than two leaves at a node. But the arrangement is such that the leaves are at a maximum distance from each other at every node. This allows them a proper exposure, Fig. 6.2(c).

Fig. 6.2(a) Alternate arrangement in rose.

Fig. 6.2(b) Opposite arrangement of leaves in jasmine

Fig. 6.2(c) Whorled arrangement in oleander.

6.2 Venation

It is the arrangement of veins on the lamina of the leaf. The veins may form a fine network as in a peepal leaf or they may run parallel to each other as in maize. A network of veins is known as **reticulate** venation and the parallel arrangement is called **parallel** venation, Fig. 6.3. Wheat, rice and grasses show reticulate venation.

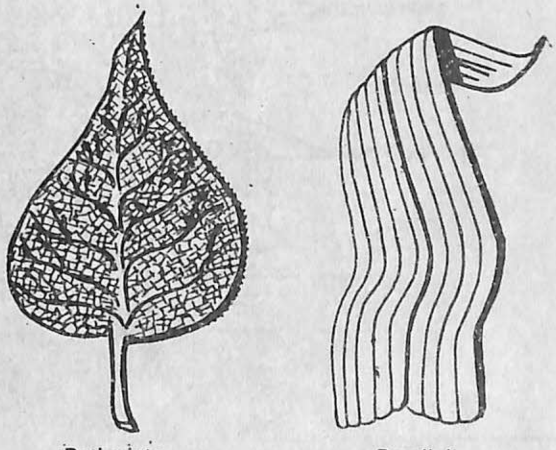


Fig. 6.3 Venation in leaves.

6.3 Structure of the Leaf

Regardless of shapes and sizes all leaves are composed of the same tissues, i.e., epidermis, mesophyll and vascular bundles.

A thin vertical section of a leaf under a microscope will show the three types of tissues in the following sequence. **Epidermis** forms the upper and lower surface of the leaf. It is a single layer consisting of colourless parenchymatous cells, compactly arranged. It is coated with a very thin, waxy and transparent layer of **cutin**, a protective material. Epidermis protects the inner tissues of a leaf and prevents loss of water from these tissues.

The lower epidermis has a thin layer of **cutin** covering its compactly arranged cells. A number of openings called **stomata** (singular stoma) are present in between the epidermal cells. Stomata have two oval **guard** cells, Fig. 6.4. These are the only epidermal cells with *chloroplasts.* The guard cells regulate the opening and closing of the stoma thereby regulating the evaporation of water vapours from the internal tissues of the leaf. Carbon dioxide diffuses into the leaf through these pores while oxygen diffuses out through the same during photosynthesis.

Just the reverse happens during respiration. Oxygen is taken in and carbondioxide is given out through the stomata. There are usually more stomata on the lower epidermis than on the upper epidermis. In vertical leaves stomata are evenly distributed on upper as well as on lower surface. In between the upper and lower epidermal layers **mesophyll** tissues are present. This tissue in dicot leaves can be distinguished into two distinct layers.

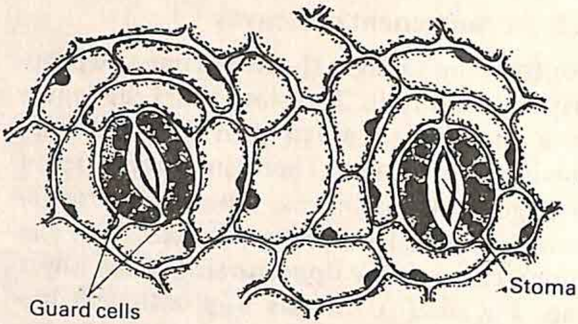


Fig. 6.4 Stomata in the epidermis

The upper layer is **palisade** parenchyma layer and the lower one is known as **spongy** parenchyma, Fig. 6.5. Palisade layer is formed of closely packed, elongated cells containing plenty of chloroplasts with green chlorophyll pigments. It is here that maximum photosynthesis takes place. Spongy parenchyma layer consists of thin walled cells full of cytoplasm and water. These cells are loosely arranged leaving plenty of air spaces between them. These cells too have chloroplasts.

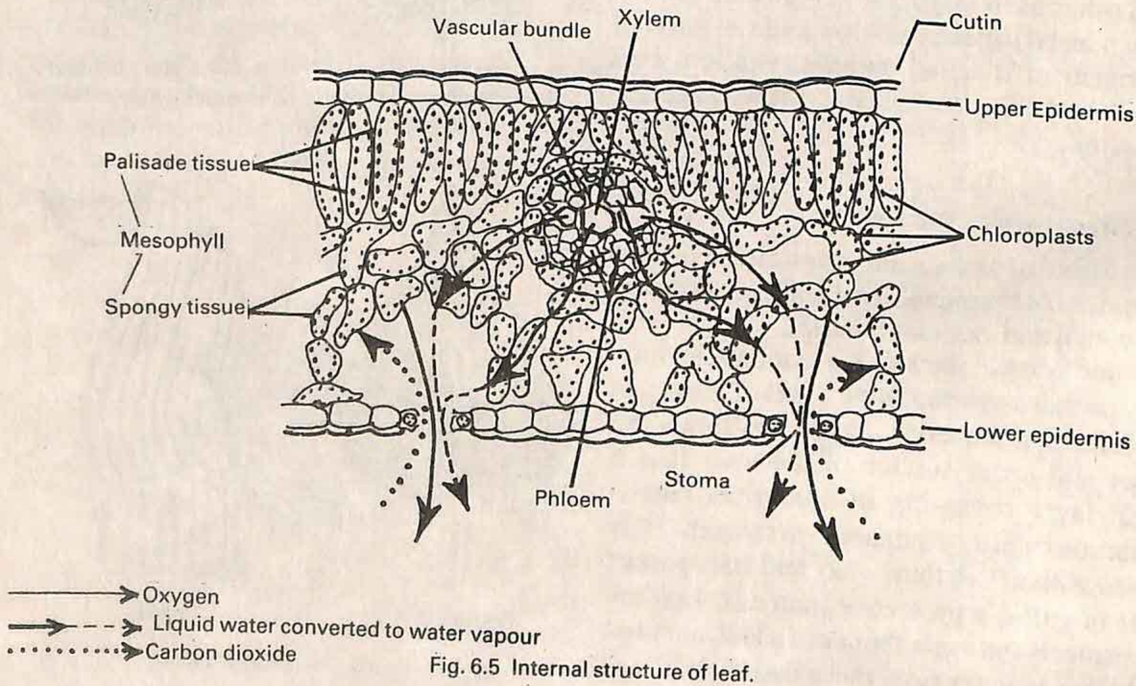


Fig. 6.5 Internal structure of leaf.

The air spaces are connected with each other and open to the exterior by way of the stomata. These air spaces receive water from the spongy cells and this water is used for photosynthesis and excess water evaporates through these pores.

Through these air spaces oxygen and carbon dioxide pass to all the cells of spongy layer as well as palisade layer. The mesophyll or the ground tissue of a leaf is thus specialized for photosynthesis.

Vascular Bundles

Mesophyll of the leaf consists of a system of vascular bundles which form the veins on the surface of the leaf. Veins are formed of xylem and phloem tissues. The vascular bundles of the leaf are connected with those of the stem. The veins carry water, dissolved minerals and food materials between the leaf and the stem. The leaf carries on special functions because of the specialized structure and position of its cells. Most important of these functions are photosynthesis and transpiration.

6.4 Photosynthesis

Photosynthesis is the process by which living green plants combine carbon dioxide and water in the presence of light energy and chlorophyll pigments to form sugars. During this process the cells release oxygen as a waste product. From these basic sugars plants and animals build other food substances such as, starch, proteins, fats and vitamins.

Activity 1: Pluck a green leaf from a plant. Boil it in water for sometime. Then place the leaf in a beaker containing methylated spirit. Place this beaker in a larger beaker containing water and apply heat to the larger beaker, Fig. 6.6. This arrangement of indirect heating prevents methylated spirit from catching fire. Continue the heating for a while. Take out the leaf from the spirit and place it in lukewarm water. This leaf has lost all its chlorophyll so it is pale white in colour. Next dip the leaf in iodine solution. You will observe that it turns blue. This is because iodine solution reacts

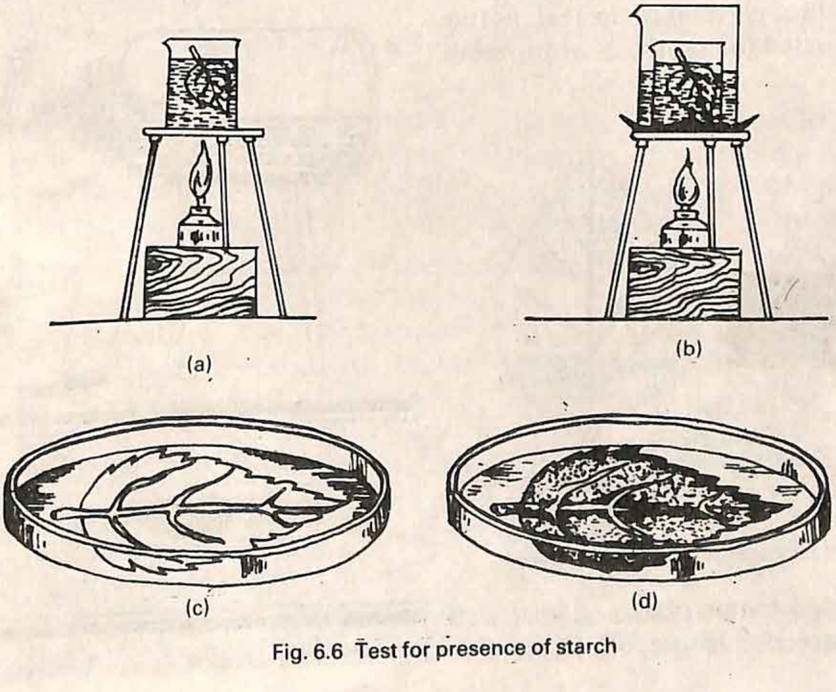


Fig. 6.6 Test for presence of starch

with starch to give the blue colour. This indicates the presence of starch in green leaves.

Activity 2: Take a potted plant and water it well. Keep it in a dark place for 72 hours. Pluck a leaf and test it for the presence of starch. Proceed with the experiment only if the test for starch is negative. Cover a portion of a leaf of the starch-free plant with a strip of black paper. Fix the paper on the leaf with the help of a clip, Fig. 6.7.

Next place the potted plant in sunlight for a few hours. Pluck the covered leaf from the plant and test it for starch. You will find that only the portion of the leaf exposed to sunlight has prepared starch. Thus sunlight is absolutely essential for starch formation.

For preparing starch green plants take in carbon dioxide from the atmosphere. It enters the leaf through the stomata. On entering, it comes in contact with the water film covering the spongy and palisade cells and dissolves in it. Thus it is absorbed and finally it reaches the chloroplasts of palisade and spongy cells. Water and dissolved minerals reach the palisade tissue through veins of the leaf, as the minerals are needed for synthesis of proteins from sugars.

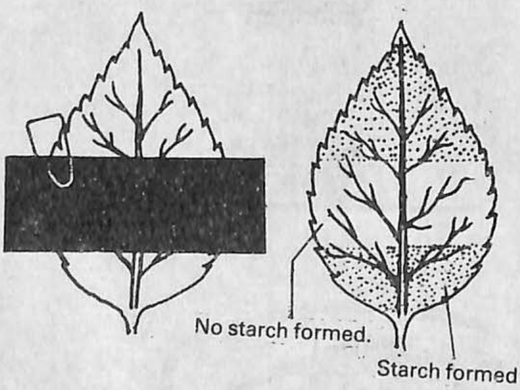


Fig. 6.7 Light is necessary for photosynthesis.

Activity 3: Place a potted plant and keep it in darkness for two days to prevent starch formation. While the plant is still in darkness test a leaf for starch. If the test is negative carry on with the activity. Take a wide mouthed bottle containing potassium hydroxide and place it on a stand as shown in Fig. 6.8. Place the potted plant next to it and fix one of its leaves between two pieces of cork. Fix the cork into the mouth of the bottle such that only half of the leaf remains outside. Keep the apparatus in sunlight for a few hours.

Test the leaf for the presence of starch. You will observe that starch is present in only that portion of the leaf which was outside the bottle. The reason for this is that the section of the leaf inside the bottle had no carbon dioxide. The potassium hydroxide solution absorbed all the carbon dioxide. Thus we see that over and above sunlight, plants also require carbon dioxide to photosynthesize.

Chlorophyll pigments present in the chloroplasts absorb sunlight. These pigments are very sensitive to light. It is here in the chloroplasts of the palisade and spongy cells of the leaf that sugars are synthesized. These

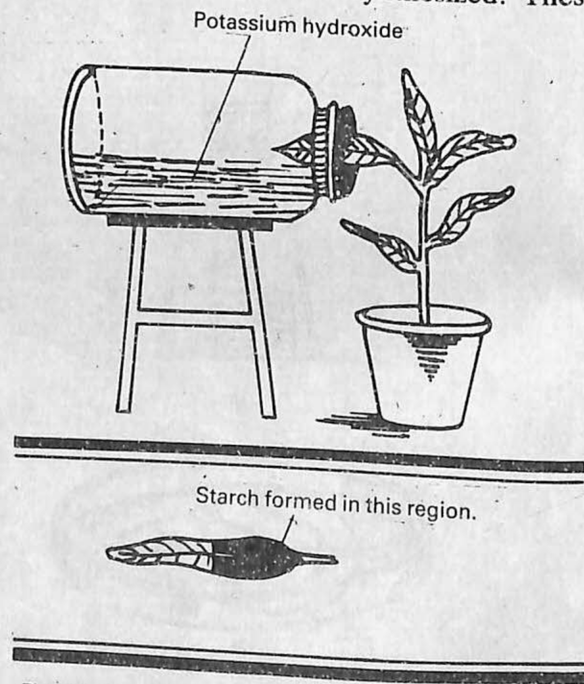


Fig. 6.8 Carbon dioxide is essential for starch formation.

pigments trap the solar energy and make it available to cells. These cells utilise this energy to prepare glucose from the raw materials, water and carbon dioxide.

Activity 4: Select a croton plant. Its leaves have patches of yellow which lack chlorophyll. Expose this plant to sunlight for a few hours. Pluck a leaf and test for starch. It is found that only the areas which were green turn blue. The yellow patches remain as such. This shows that photosynthesis occurs only in the areas where chlorophyll pigments are present. In other words the yellow patches are unable to photosynthesize as they are lacking in chlorophyll.

Oxygen and excess of water vapours diffuse out of the leaf through the stomata. Sugars get accumulated in large quantities to form starch. Sugars and starches are moved through the phloem tissue of the vascular bundles, to other parts of the plant, i.e, roots, fruits, growing tips, etc. The process can be summarized in the following equation:

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} \underset{\text{Glucose}}{C_6H_{12}O_6} + 6O_2 + 6H_2O$$

Water and carbon dioxide are the raw materials while sugar and oxygen are the end products. Prerequisites of this reaction are the chlorophyll pigments and sunlight.

Activity 5: Take a beaker containing water. Place a few water plants in it and cover them with a funnel, as shown in Fig. 6.9. Invert a test tube filled with water over the stem of the funnel. The entire apparatus should then be placed in sunlight for a few hours. After some time you will observe bubbles of gas arising in the test tube. Let the gas collect in the test tube. Remove it from over the funnel by placing a finger over the mouth of the test tube.

Care should be taken to assure that no air enters the test tube. Lower a glowing splinter into the test tube. What do you observe? The splinter bursts into flame thereby indicating that the gas is oxygen. Thus green plants release oxygen during photosynthesis.

Sugar contains stored energy in the form of chemical energy which is later released in the body of animals and plants when taken as food. Fats are formed from sugar and starches in the storage organs of plants, such as seeds, fruits, etc. Proteins are formed from sugars and minerals in certain portions of the stem. Thus we find alongwith water minerals from the soil are also necessary.

Factors Affecting Rate of Photosynthesis

Various factors inside the plant as well as in the surroundings of the plant affect the rate of photosynthesis.

Internal Factors

Conditions of the food making cells should be healthy and active. They should have plenty of chlorophyll pigments and an adequate supply of water. They must also have plenty of minerals for the synthesis of chlorophyll pigments and other food substances.

External Factors

The leaf should get sufficient sunlight so that chlorophyll pigments are able to absorb solar energy. Apart from manufacturing food light is also necessary for the formation of more

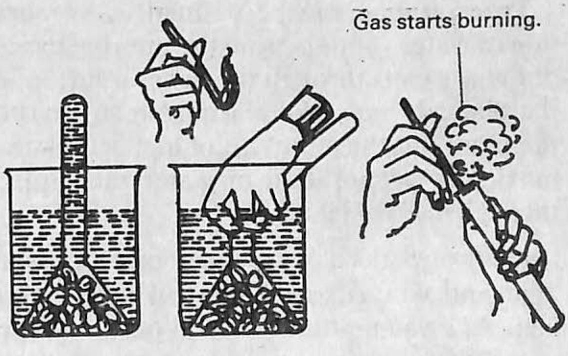


Fig. 6.9 Oxygen is released during photosynthesis

chlorophyll pigments. Photosynthesis is maximum in the early morning hours, when light and temperature both are favourable. At noon the light is too intense and the stomata close. The rate of photosynthesis then decreases.

In the evening as the sun sets the rate of photosynthesis slows down and stops entirely at night. Sugars dissolve in water and get translocated to different parts of the plants during the night. Next morning the food making cells are cleared of stored starches and are ready for making more sugars.

Temperature is a very important factor as it affects cell activity. At low as well as very high temperatures the rate of photosynthesis slows down. It is optimum at 80° to 90° F. The carbon dioxide content of the environment is another important factor as it is a necessary raw material. With the increase in the carbon dioxide content in the surroundings of the plants there is an increase in the rate of photosynthesis.

6.5 Transpiration

Plant conducts a continuous stream of water along with dissolved minerals, upwards through its roots, stem and leaves. Water is used by cells for its life activities. However much more water is absorbed than the plant can use. Excess of water escapes through the leaves.

Transpiration can be defined as evaporation of water vapours from the internal tissues of living plants through the general surface of the plant. It may take place from any part of the plant but the structure of leaf is such that maximum evaporation of water takes place through the stomata.

Activity 6: Take a potted plant place it in sunlight and wrap its leafy part in a polythene bag. After some time you will observe droplets of water on the inner side of the polythene bag, Fig. 6.10. These are the water vapours which evaporated from the leaves and got condensed on the cool surface of the polythene bag.

Mechanism of transpiration

Each stoma opens into a small air chamber which is lined with spongy mesophyll cells. The evaporating surface of a leaf consists of these spongy cells whose walls are saturated with water. As evaporation proceeds water vapours accumulate in the air chamber and escape through the stomatal openings into the surrounding atmosphere. As the water evaporates more water is drawn into the leaf through its veins.

Any factor affecting the opening and closing of stomata will obviously effect the rate of transpiration. The opening of a stoma is controlled by the shape of the guard cells. When these cells are full of water they swell outward and increase the opening and water vapours

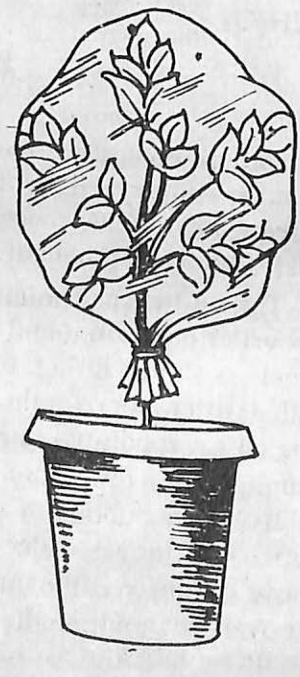


Fig. 6.10 Leaves transpire.

escape rapidly. But when they shrink due to lack of water they collapse against each other closing the opening and reducing evaporation of water.

The opening and closing of stomata is also affected by external factors like heat, light, water supply, air movements, etc. On a hot day when sunlight is too intense the stomata close. But the leaf continues to loose water at a high rate through the epidermis due to heat in the surroundings. As a result the leaves droop, i.e., wilt. Such wilting of leaves ceases in the evening when the atmosphere cools and absorption of water from the soil makes up for the water deficiency.

6.6 Respiration

Oxygen enters the leaves through the stomata. It combines with sugars, in the leaf cells and breaks down sugars into carbon dioxide and water. During this breaking down process chemical energy which was stored in sugars is released and this energy is utilized by the cells for their various life activities. This process of breaking down sugars in presence of oxygen is called *oxidation*. The oxidation of sugar to obtain energy is known as **respiration.** In green plants respiration occurs at a higher rate in leaves and stems because of their close contact with the atmosphere.

During respiration carbon dioxide and water are formed as waste products. Carbon dioxide is given out through the stomata. In the hours of sunlight rate of photosynthesis is higher than respiration. Thus during the day carbon dioxide is used for photosynthesis but at night it is released through the stomata. Photosynthesis prepares sugars while respiration breaks them down. Hence we see that respiration is just the reverse process of photosynthesis.

In all plants rate of photosynthesis is much higher than that of respiration. That is why inspite of sugars being used by plant tissues for their own needs there are plenty of sugars left to be stored in the plant. Plenty of oxygen is released by plants during the day time making the air fresh for breathing. We can summarize respiration in the form of the following equation.

Sugar + Oxygen + Water $\longrightarrow$
Carbon dioxide + Water + Energy

EXERCISES

1. Write a line about each of the following:

   (i) Alternate arrangement: ______________________________

   ____

   ____

   (ii) Opposite arrangement: ______________________________

   ____

   ____

   (iii) Whorled arrangement: ______________________________

   ____

2. Draw a detailed diagram of the internal structure of the leaf.

3. How is the leaf structured to aid photosynthesis? ______________________

4. How are chlorophyll pigments useful to plants? ______________________

5. During the course of the day how does the rate of photosynthesis vary? ______________________

6. What role do the guard cells play in controlling the rate of transpiration? ______________________

7. Resipiration is the reverse of photosynthesis. Justify. ____________________

____

____

____

____

____

____

8. Fill in the blanks.

(i) ____________ venation is found in wheat, rice and ____________ .
The veins form a network in ____________ venation.

(ii) ____________ forms a protective waxy layer on the epidermis.

(iii) The ____________ tissues occupy the region between the upper and lower epidermis.

(iv) ____________ is the loss of excess water from the leaf surface.

(v) The breaking down of sugars in the presence of oxygen is known as ____________ .
The oxidation of sugars to obtain energy is termed as ____________ .

7

Flowers, Fruits and Seeds

We generally visualise a flower as that bright coloured part of a plant, that adorns either the plant or a flower vase. But not all flowers are bright and neither are they only of ornamental value. The flower is the reproductive organ of a plant. It produces seeds from which new plants arise. In scientific terms flower is a specialised branch bearing groups of highly modified leaves at its tip. There are endless variations in a flower structure. However we will consider a generalised structure of the flower.

7.1 Structure of a Flower

A typical flower has four different kinds of structures attached at successively higher levels of the flower stalk called a **pedicel.** The swollen tip of the pedicel is called a **receptacle.** The different parts of the flower are arranged in rings or **whorls.** The whole flower is borne in the angle between a leaf and the main stem or a branch. Thus a flower takes the position of an axillary bud or a terminal bud.

The lower and outermost ring or whorl of a flower consists of green structures called **sepals** resembling leaves. All the sepals together form a ring called **calyx,** Fig. 7.1. It covers and protects the flower in the bud stage. Inner to the calyx is the second whorl, called a **corolla.** It consists of a number of, often brightly coloured structures called **petals.** These too are leaf-like in shape, Fig. 7.1. The corolla attract insects and also protect the inner two whorls of the flower. There can be different forms of corolla, for example, it may be like a tube, a funnel, or like a cross formed of four petals.

The third whorl of a flower is the **androecium.** It consists of many **stamens.**

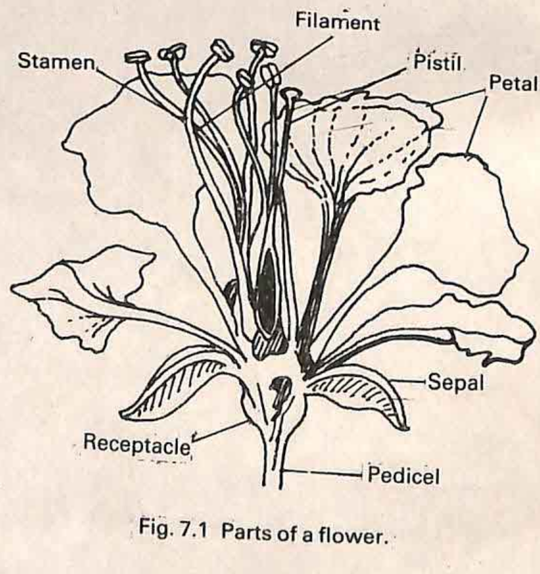


Fig. 7.1 Parts of a flower.

Each stamen, a male reproductive structure, consists of an elongated stalk called **filament** and an expanded knob-like structure at its tip, known as **anther.** The anthers contain sacs which produce a large number of yellow powdery grains called **pollens.** Most of the anthers are bilobed, having two pollen sacs, Fig. 7.2. Pollens play an important part in reproduction by producing male sex cells called **gametes.**

The fourth and the central whorl of a flower consists of a **carpel** or pistil. It is the female reproductive structure. Each carpel has a swollen base called **ovary**, extended into a **style** and it bears a flattened, sticky **stigma** at its tip, Fig. 7.2. In most of the flowers carpels are fused together to form one big ovary having many chambers.

Inside the ovary are knob-like structures called **ovules.** Ovules are attached to the ovary either at its base, or along the sides or to a central axis, running lengthwise, from the base of the ovary to the base of the style. The number of ovules may vary from one to many. The tissue to which the ovules are attached is called **placenta**. Ovules derive nourishment through this tissue during their development into a seed.

Initially the ovule consists of a uniform mass of cells. As it develops the walls of the ovule differentiate into two layers, the inner and outer **integuments.** These two integuments do not completely enclose the cellular mass but leave a small opening at one end known as **micropyle,** Fig. 7.2.

In the centre of the ovule there is a sac called the **embryo** sac. This contains the female gamete, the **egg** cell. The egg cell is the large nucleus in the embryo sac, present near the micropyle. In addition to the egg cell there are seven more nuclei present in the ovule. Two nuclei are in the centre of the sac and they fuse to form an **endosperm** nucleus, Fig. 7.2.

If a flower has both the male and female whorls it is said to be a **perfect** or a **bisexual** flower. But if the flower has one of the sexual whorls missing it is said to be a **unisexual** flower. The gulmohar flowers have both stamens and pistils while gourd and cucumber are examples of unisexual flowers. A **complete** flower has all the four whorls, e.g., lily, rose, an **incomplete** flower on the other hand has any one whorl missing, e.g., mulberry.

7.2 Pollination

Pollens from anthers of a flower are transferred to the stigma of the same flower or any other flower of the same species. This transference of pollens from an anther to a stigma is known as **pollination.** This is a very important phase of reproduction.

If the transfer of pollens is from the anther to the stigma of the same flower it is known as **self** pollination. But if the pollen is transferred from the anther of one flower to the stigma of another flower it is **cross** pollina-

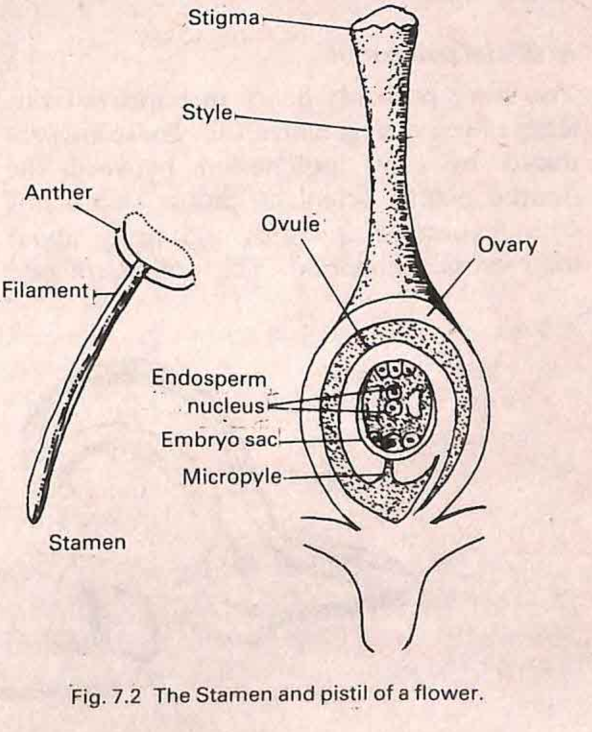


Fig. 7.2 The Stamen and pistil of a flower.

tion. In self pollinated flowers the stigma is placed lower than the anthers so that pollens can easily fall on it. Cross pollination requires an outside agent such as the wind, water or insects, which will carry pollens from one flower to another.

Flowers have adapted themselves in various ways to attract insects for pollination. Insects such as bees, butterflies, moths, etc., visit various flowers attracted either by their bright colour or fragrance or in search of food, i.e., pollens or nectar. While visiting a flower the insect sits on it pollens stick to its legs and back. When it visits another it accidently transfers the pollens from the first flower to the stigma of the second flower. In this way the flower gets pollinated, Fig. 7.3.

Wind pollinated flowers are usually in clusters and produce a large quantity of pollens so that at least some of them may fall on stigmas of flowers. Styles of wind pollinated flowers are usually long and hang out in the form of hairs. Their stigmas are sticky so that pollen grains that are blown about by the wind may stick to them.

Artificial pollination

You have probably heard of improved varieties of fruits, vegetables, etc. These are produced by cross pollination between the desired plants. Scientists choose two plants with favourable qualities and bring about their cross pollination. The pollens of one such flower are collected and dusted on to the stigma of the other flower. The anthers of the second flower are removed to prevent self pollination. Also after pollination the flower is wrapped in a plastic bag so that pollens of other such flowers do not fall on it. This method of **artificial** pollination is very popular among gardeners and horticulturists. It helps to retain the good qualities of both the breeds involved in artificial pollination.

7.3 Flower and Reproduction

The flower is responsible for reproduction and maintenance of the plant species. It does so by the formation of fruits and seeds. Once the pollen grain lands on the stigma, the pollen starts growing and forms a tube-like structure called a pollen tube. This tube pierces and passes through the soft tissues of the style, ovary wall, stalk of the ovule and reaches near the micropyle of the ovule. It travels further to reach the embryo sac, Fig. 7.4.

The tip of the pollen tube dissolves on reaching the embryo sac and the two gametes are released. One gamete enters the embryo sac and fuses with the egg cell while the other fuses with the endosperm nucleus.

The fusion of the male and female reproductive cells is known as **fertilization.** The fertilized egg then becomes a **zygote.** This grows inside the ovary and becomes a young embryo

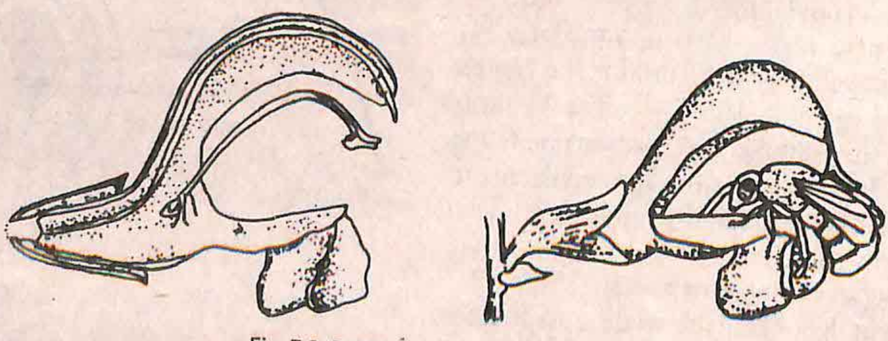


Fig. 7.3 Pollination of sage flower.

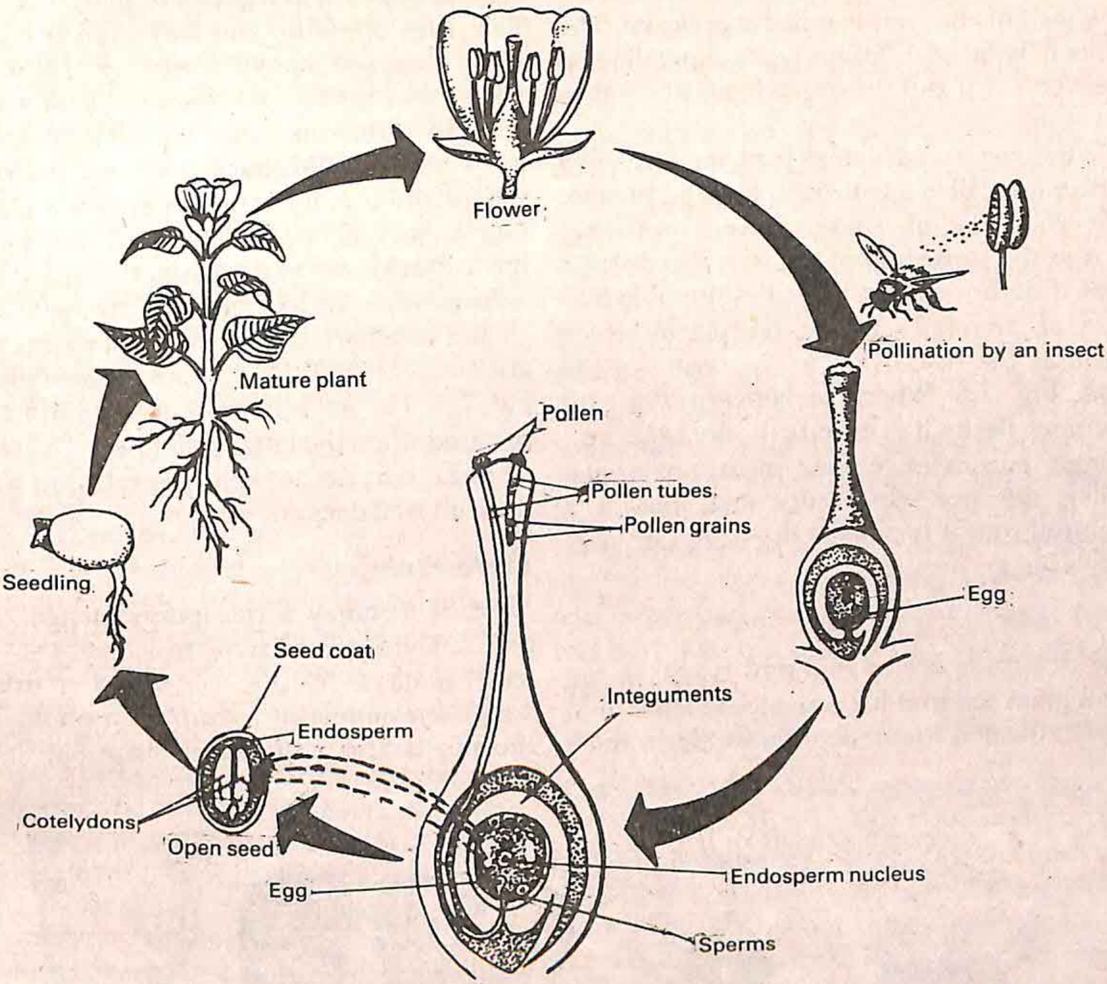


Fig. 7.4 Sequence of events in the fertilization of a flowering plant.

plant. The embryo consists of an axis to which two **cotyledons** are attached and one end of the axis is known as a **plumule** while the other is known as a **radicle.** The integuments of the ovule change into two **coats** enclosing the embryo within.

Thus when the ovule develops into a seed it has an embryo surrounded by two seed **coats.** The other cells of embryo sac provide nutrition to the developing embryo and thus get consumed. Each ovule needs one pollen grain to fertilize its egg. Ovaries having a large number of ovules need that many number of pollens to fertilize them. After fertilization petals and sepals fall off. Stamens wither off and only the ovary remains. Ovary starts growing and develops into a fruit while the ovules develop into seeds within the fruit.

7.4 Fruits

After fertilization the ovary starts developing and increases in size. The wall of the ovary at times splits into two or three layers or remains as a single layer. The fruit is a ripened ovary

with or without associated parts of the flower. The wall of the fruit is called a **pericarp.** The fruits may be of different types depending on their pericarp and the organ from which they develop.

When the fruit develops from the ovary of a flower it is called a **true** fruit, for e.g., mango. But when any other part of the flower takes part in the formation of the fruit it is called a **false** fruit. For example, the fleshy edible portion of an apple is the receptacle which encloses the true ovary in the centre of the fruit, Fig. 7.6. When the pericarp of a fruit becomes fleshy it is called a fleshy fruit, i.e., mango, cucumber, tomato, pear, apple, etc. When the pericarp is dry and thin in a matured fruit it is called a dry fruit, i.e., pea, lady's finger, nuts, etc.

Dry Fruits

The dry fruits are of different types. In the bean plant the fruit has a single chamber with seeds attached to one margin inside it. Such fruits are known as **legumes** or **pods**, Fig. 7.5. The fruits of cotton and lady's finger on the other hand are many chambered. These are known as **capsules.** At times the fruit wall is separated from the seed coat and a single carpel forms the fruit. Such fruits are known as **achene** and contain a single seed, for e.g., the four o'clock plant. In the sun flower family the fruit is known as a **cypsela,** Fig. 7.5.

In another variety of fruits the seed coat cannot be separated from the fruit wall as they are fused. Such fruits are known as **caryopsis**, Fig. 7.5. The seeds of most of these fruits are released when the latter split open. The seeds of those that do not split are released when the fruit wall decays.

Fleshy Fruits

Most of us enjoy a ripe pulpy mango. The pulp contains a hard stone which encloses the seed. Such a fruit is known as a **drupe.** Another example of a drupe is a plum. The coconut is also a drupe. It has a hard shell

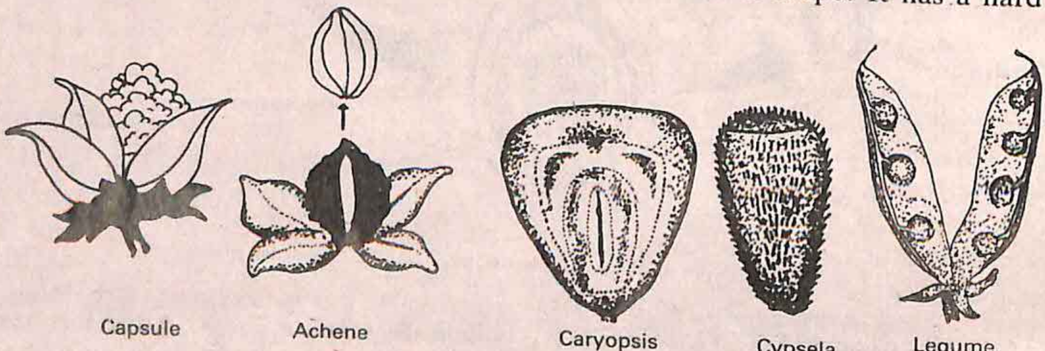


Fig. 7.5 Dry fruits.

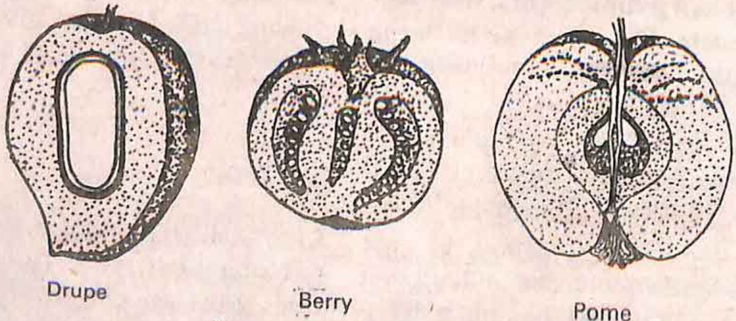


Fig. 7.6 Fleshy fruits.

enclosing the nut while the middle portion is fibrous. The tomato is another fleshy fruit with pulp under its skin. There are a number of seeds embedded in the pulp. Such fruits belong to the category of **berries**, Fig. 7.6. Apples and pears have the receptacle as the fleshy edible portion while the actual fruit forms the core, Fig. 7.6. This type of fruits are known as **pomes.** These fruits do not split open to release the seeds. They are released only when the fruit decays. Man and other animals may eat the fleshy region and throw away the seed.

7.5 Seeds

The ovary develops into the fruit and the ovules form seeds. You have studied in your earlier class how the seeds germinate when proper conditions of growth are available. They require moisture, oxygen and appropriate temperature for growth. Most seeds go through a rest period before they germinate. The rest period is called the **dormant** period and it varies from plant to plant. Some seeds remain dormant through winter and start sprouting during the following spring.

Dormancy helps the seed to survive through unfavourable weather conditions. When appropriate temperature and moisture is available along with adequate amounts of oxygen germination occurs. The ability of seeds to germinate after a period of dormancy is called **viability.** Some seeds remain viable even after being stored for years together.

Dicotyledonous Seed

The bean, gram and pulses belong to this group. It is a kidney shaped seed and is covered by a outer seed coat called **testa** and an inner thin coat called **tegmen.** An oval scar on the inner concave side marks the place where the seed was attached to the fruit wall and is called **hilum.** When the two seed coats are removed by soaking the seed in water for two days, what remains within is the **embryo**, Fig. 7.7(a). It consists of an axis to which two fleshy cotyledons (seed leaves) are attached, hence the name dicot.

The radicle forms one end of the axis while the plumule at the other end is feathery, having many leaves clustered together. The small leaves enclose a very tiny terminal bud which later on grows into the shoot tip while the radicle grows into a root. The cotyledons protect the plumule and store food for the growing embryo.

Monocotyledonous Seed

It has only one cotyledon as the name suggests and it does not store food. Food is stored in the endosperm tissue instead. As the embryo developes it obtains its food from the endosperm. The epithelium separates the endosperm from the embryo, Fig. 7.7(b). Its function is to digest and absorb the food stored in

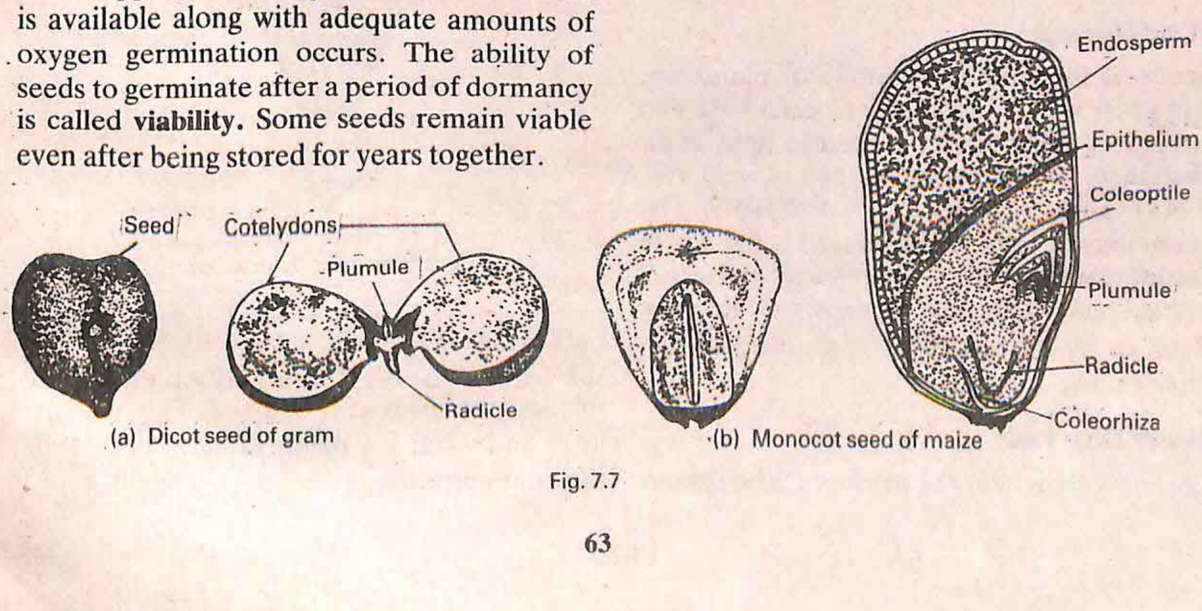


Fig. 7.7

the endosperm. The plumule is protected by a sheath called **coleoptile** while the **coleorhiza** protects the radicle. Maize, rice and wheat grains are monocotyledons. The ovary wall in this case is fused with the seed coat.

7.6 Dispersal of Seeds

Seeds must be carried to far off places from their parent plants. In case they start growing near the parent plant there would be a struggle for survival due to lack of sufficient light, water and space. The new plants will compete with the parent plants for their requirements. This would retard the growth of the parent plants. To avoid this Nature has made provisions for the fruits and seeds to develop devices which enable them to be scattered as far as possible from the parent plants.

Mechanical dispersal

Pods and legumes of pea, beans and pulses often twist as they mature. This causes strain on the legume and it bursts open suddenly, with enough force to throw the seeds at some distance. In balsam the legumes open and curl inwards violently with the result that seeds are thrown several feet away.

Wind, water, birds and other animals are also involved in dispersing fruits and seeds.

Wind Dispersal

Seeds of the sunflower family of plants are equipped with minute, hairy, parachute-like structures which help the seed to float in air and to be carried to different places, Fig. 7.8(a). Silk cotton seeds are also hairy. The seeds may develop membranous wings which facilitate wind dispersal. The wings of fruits of certain plants help as tiny propellers and carry them to far off places, for e.g., ash, shorea, hiptage, Fig. 7.8(b).

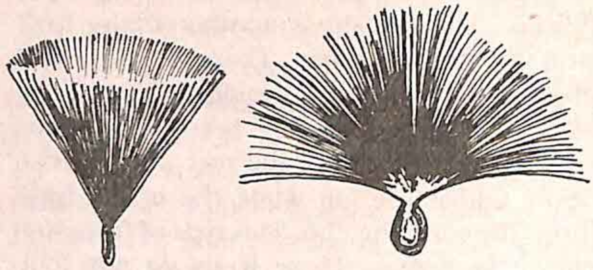


Fig. 7.8 (a) Seeds with tufts of hair

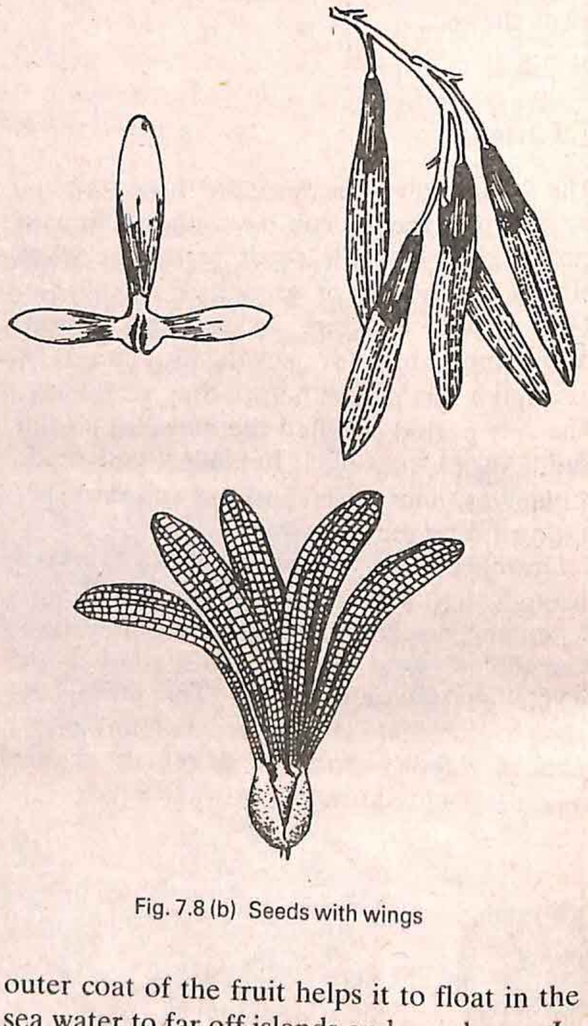


Fig. 7.8 (b) Seeds with wings

Water Dispersal

Coconuts grow near the sea shore. The fibrous outer coat of the fruit helps it to float in the sea water to far off islands and sea shores. In this way the seeds get dispersed. The seeds of lotus and water-lily plants are also dispersed by water currents.

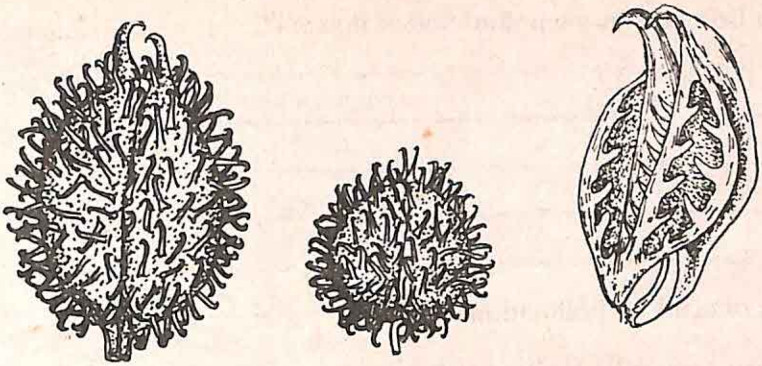


Fig. 7.8 (c) Seeds with hooks.

Dispersal by Birds and Animals

Birds and other animals feed on fleshy fruits and scatter the seeds to distant places. Certain seeds have hooks which stick to the fur of animals and get carried to far off places, Fig. 7.8(c). On several occasions you may have found thorny seeds attached to your clothing. Such seeds are carried to distant places by us.

EXERCISES

1. Draw and label the different parts of a flower.

2. Differentiate between the two types of pollination. ____________________

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3. How do insects bring about the pollination of flowers? ________________

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4. What is the use of artificial pollination? ________________

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5. Give a diagrammatic representation of fertilisation in plants.

6. How are seeds dispersed by the wind? ________________

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7. Fill in the blanks:
   (a) A ________________ fruit develops from the ovary of a flower.
   (b) The wall of a fruit is known as ________________.
   (c) The rest period in seeds is called ________________.
   (d) ________________ is the ability of seeds to germinate after a period of dormancy.
   (e) In a dicot seed the outer seed coat is called ________________ and the inner one is known as ________________.
   (f) In the monocot seed the ________________ protects the plumule while the radicle is protected by the ________________.
   (g) Seeds dispersed by birds and animals have ________________.

8. Match the following:

(a) A many chambered fruit	(i) Berry
(b) A fruit with a single chamber and seeds attached to one margin	(ii) Achene
(c) In the sunflower family the fruit is known as	(iii) Capsule
(d) Seed coat is fused with the fruit wall in	(iv) Legume
(e) A fleshy fruit with a stone embedded in the pulp is known as a	(v) Pome
(f) When the receptacle forms the fleshy edible portion of a fruit it is called a	(vi) Cypsela
(g) When a number of seeds are embedded in the pulp it is known as a	(vii) Caryopsis
(h) When a single carpel forms the fruit and the seed coat is separated from the fruit wall it is said to be an	(viii) Drupe

8

Useful and Harmful Plants

A large number of plants and their products are used for the well being of mankind. They provide us with food, clothing and shelter. They also provide raw materials for many industrial products. Numerous plants are used to ease pain and also to cure illnesses. Ornamental plants add to beauty. Unfortunately some plants cause allergy such as hay fever, produce poisons that kill livestock, etc. Drug's obtained from plants like hemp and poppy cause drug addiction and bring misery to millions.

Many of the useful plants occur in nature in forests and a good number of them are cultivated for food and industry.

8.1 Classification of Crops

Classifying plants as useful and harmful is a very general method. Another way of categorising them is as **crops.** Crops are plants that are grown and cared for in fields or farms on a large scale, for the use of man, for e.g., grains, fruits, seeds and legumes. Crops raised not so much for household consumption but more for obtaining cash are known as **cash** crops.

Yield of crops is measured in terms of their weight and area covered. Generally the yeild is measured in kg/hectare or acre. Different crops are sown and harvested in different seasons. On this basis we have two types of crops in India, **rabi** and **kharif.** Rabi crops are grown during the winter season and are harvested at the end of the season. Wheat, mustard and gram are rabi crops while kharif crops, i.e., bajra, cotton and maize are grown in the rainy season.

Activity 1: Make a list of the cereals and vegetables used in the household and find out which of them are rabi crops and which are kharif crops.

A particular type of soil is suitable for a particular crop. Thus different parts of our country produce different crops according to their climate, soil and rainfall. In India the crops harvested are cereals, edible oils, groundnut, cotton, sugarcane and spices. **Cereals** are edible grains obtained from cultivated grasses. Wheat, rice, corn, oats, barley are well known cereals. They constitute the staple diet of human beings all over the world.

All cereals are rich in starch and vitamins A, B and C. They are cultivated as annual

crops and all of them belong to the family called gramineae. Rice, wheat and maize are the major cereals while juar and bajra are millets. Cereal cultivation in India occupies about 60% of the total land under cultivation.

8.2 Paddy *(Oryza sativa)*

It is the major agricultural crop in India and occupies 37% of the 60% area under cereal cultivation. It contains 70–80% starch, 7% proteins, 1.5% oils and vitamin A, B, and C. Rice straw provides fodder for cattle while its starch is used for preparing alcoholic beverages. Oil is obtained from rice bran.

It is a monocotyledonous plant growing on all types of soils. It requires standing water for proper growth. Rice has a shallow root system. The grain develops from the flower and remains surrounded by a covering called **husk.** The rice in this form is known as **paddy,** Fig. 8.1. When the husk is removed it is called cleaned rice. The grain is coated with pigments. In polished rice this pigmented layer full of vitamins is lost, as also in throwing away the starch after boiling rice.

The crop thrives under conditions of moderately high temperature and plenty of rainfall or proper irrigation. 90% of rice cultivation in India is wet paddy cultivation, i.e., plants remain in standing (but not stagnant) water. The land is ploughed and then manure or compost is added and mixed thoroughly. Paddy seeds are sown in seed beds in the nursery and watered regularly. When the seedlings are 20 cm high they are ready to be transplanted in the field. The field is flooded with water a month before transplanting the seedlings. It is thoroughly ploughed and then levelled. The seedlings are uprooted from the nursery in small bundles.

Three or four seedlings are sown together either by hand or with a seed drill. Such groups of seedlings are planted in rows at a distance of 20–30 cm apart. This is known as line sowing. Before harvesting the field is drained of water and made dry. It is kept dry for sometime before irrigating it again. While the plant is in the nursery or in the field it may get infected with the seed-borne disease **root rot.** The infected plants increase in length and become yellow in colour.

Fig. 8.1 Paddy

Another disease which affects the paddy plant is **blast.** In this disease brown spots appear along the margins of leaves. Both the diseases can be checked by spraying chemicals. The pests such as stem borer and gundhy bug cause immense damage to the paddy crop, the former bores holes into the stem and the latter feeds on the ripe grians. The paddy crop takes nearly five to six months to mature. When it becomes golden yellow in colour it is ready to be harvested. The crop may be harvested with a sickle or with huge machines called **combines.** The plants are then dried and threshed to separate the grains from the chaff. The husked grains thus separated are stored in granaries.

Jaya, Padma, IR 8, IR 24 are the high yielding and disease resistant varieties.

8.3 Wheat (*Triticum aestivum*)

It is the staple diet of at least a third of the worlds population. In India it is extensively cultivated in Punjab, Haryana, U.P. and Bihar. The wheat stem is erect and cylindrical and is known as **culm**, Fig. 8.2. The nodes are solid and internodes are hollow. Wheat being a monocot plant has a fibrous root system. Its shoots which arise from the basal portion are known as **tillers.** The leaves are narrow and long. The wheat inflorescence is known as **spike.** The grain develops from the flower and is surrounded by two bracts or **glumes**. The spike is also known as **ear.**

In India wheat is mainly a winter crop, i.e. it is a rabi crop. This crop is sown in October – November and is harvested in May or June. Wheat is grown in rotation with other crops, such as, maize, bean, etc. **Mixed** cropping is also practised, i.e., wheat and mustard or gram are sown together in the same field. Before sowing the field is ploughed eight or nine times and then levelled. In between the ploughings compost is added. Sometimes certain plants are grown in the same field and are mixed with the soil as green manure. Seeds are sown in rows in the furrows made by the plough or scattered in the field. The land is once again levelled after sowing.

The water requirements of different wheat crops are quite different. In addition to the monsoon the tall variety of wheat requires only two irrigations during the crop season. One irrigation is needed after four to six weeks of sowing and the others are at the time of flowering. Whereas dwarf wheat needs four irrigations. If sowing is followed by immediate rainfall the top soil hardens. In such cases the crust is broken to allow germination. The leaves and straws of wheat plants

Fig. 8.2 Wheat field

may get infected with **rust** disease and develop brown spots. Sometimes there is a black powdery mass in the grain due to **smut** disease.

Calcium carbonate and sulphur are dusted onto the grains to prevent these diseases. Chemicals are also used to check the growth of weeds. Commercial chemical fertilizers are used before sowing to increase the yield. When the straw becomes golden yellow, the crop is ready for harvesting. The straws are cut close to the ground by means of sickles.

The wheat is threshed out by means of a sledge driven by an animal or a tractor. Nowadays mechanical threshers are used. During threshing the straw is broken into pieces and grains are squeezed out of the ears. The chaff is removed by a simple winnowing process. A person tosses the grains into the air to let the lighter hull to blow away and allows the grains to fall down.

Sonara, Lerma, Rajo, Sona 227 evolved by the I.A.R.I are some of the high yielding and disease resistant varieties of wheat.

8.4 Maize (*Zea mays*)

It is grown abundantly in U.P., Himachal Pradesh, Punjab, Bihar, Jammu and

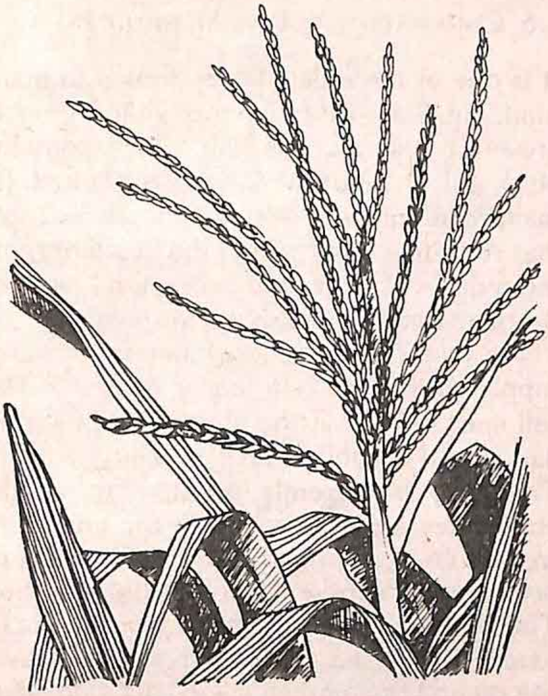


Fig. 8.3 Maize

Fig. 8.4 Sugarcane, the traditional source of sugar.

Kashmir, Madhya Pradesh, Rajasthan and Karnataka. It is usually single stemmed and succulent. This annual grass is about 1–5 cm tall, Fig. 8.3. The plant has fibrous root system. Prop roots support the plant as well as photosynthesise. It is grown on a wide variety of soils ranging from coarse sand to clays and climate varying from warm to cold. It is a water-loving crop hence moisture is necessary throughout the growing period. It requires plenty of sunshine and fertilizers. In the north, after ploughing the fields eight or nine times grains are sown in the month of June. The crop is ready by the end of October. Early maturing varieties can be sown in April and harvested in June-July, i.e., before the rainy season.

Maize must be stored in airy tanks or bins and they should be protected from rats and other insects by exposing the grains to fumes of chemicals. Maize plants and grains are the cheapest food for cattle, pigs, sheep and poultry. Leaves and stem form good fodder while grains form nutritional food for pigs, poultry and other animals.

Corn oil, corn starch and corn sugar are the chief industrial products obtained from maize. Stalks and leaves are sometimes used for making paper.

8.5 Sugarcane (*Saccharum officinarum*)

Punjab, U.P., Andhra Pradesh, Madhya Pradesh and Haryana are the main producers of sugarcane in India. This traditional source of sugar is a coarse grass with solid stems, growing 2–5 meters tall, Fig. 8.4. Sucrose extracted from sugarcane is known as canesugar.

It is a monocot plant and has a fibrous root system. It grows well in tropical and subtropical climates. An adequate supply of water is essential for cane growth, together with a dry season for ripening and reaping. The growing period of sugarcane varies from 10-18 months. The crop is harvested before flowering.

The freshly cut cane stalks are crushed to extract juice. This juice contains sucrose,

organic acids, gum, minerals, proteins, etc. The juice is filtered, purified and further processed to form crystals of sugar. Molasses are formed as a byproduct. It contains sucrose and other sugars, salts and organic compounds. Molasses are used as animal feed and fermented to form alcohol. The crushed cane stems are called **bagasse.** It is used for making paper.

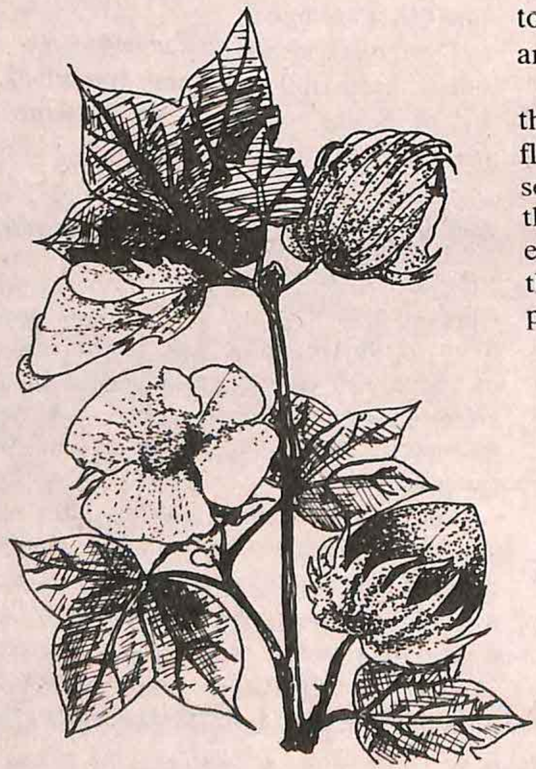
The sugarcane crop is affected by diseases such as **red rot** and **smut**. In the former the stems develop red spots and the sugar content of the affected areas reduces. In smut disease the stem appears to be covered by a thick layer of soot. Pests such as stem-borer, white grub, etc., and rodents affect the yield. Fungicides and pesticides are used as a means of control.

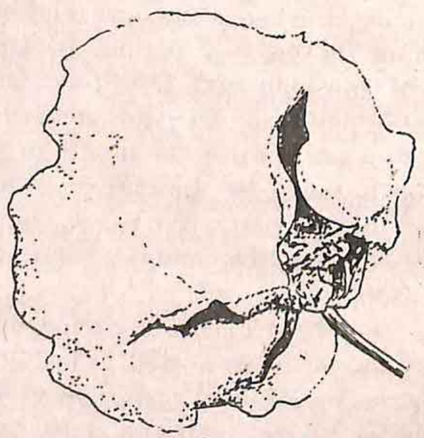
8.6 Cotton (*Gossypium hirsutum)*

It is one of the oldest fibres known to mankind, Fig. 8.5. In India this kharif crop is grown in the Deccan belt which contains black soil, commonly known as **cotton** soil. Its main requirement is adequate depth for rooting. Anything that restricts the depth of rooting reduces growth of above-ground parts of the plant and this limits the crop yield.

The crop requires a large amount of water supply. It may be rain fed or irrigated. The soil must have moisture at the time of germination and a good drainage quality as such. This crop is extremly sensitive to weeds. Herbicides are used to check the growth of weeds. On maturity the cotton capsules or **bolls** open to expose the cotton fibres within. The bolls are picked at this stage and marketed. The seeds are pressed to obtain cotton oil and the remnants, i.e., the seed **cakes** are fed to the cattle.

The boll worm and certain insects attack the cotton plant by eating away the leaves, flowers, buds or bolls. Caterpillars eat the seeds and thus reduce the yield. To get rid of the caterpillar the seeds are fumigated, i.e., exposed to fumes of chemicals and dried in the sun. Pesticides are also sprayed on the plants to keep away the pests.





Cotton boll

Fig. 8.5 Cotton, the oldest known fibre.

Fig. 8.6 Groundnut, a source of edible oil.

8.7 Oils

Groundnut (Arachis hypogea)

It is a major kharif crop of Tamilnadu, Maharashtra, Andhra Pradesh, Gujrat, Punjab, Haryana, U.P. and Rajasthan, Fig. 8.6. This nut contains 31% proteins, 45% oil and plenty of calcium, phosphorous and vitamin B. It grows on well drained and irrigated soil. At times it is grown alongwith cotton, mixed cropping, to save on time and energy. It is also grown alternately with maize and wheat to

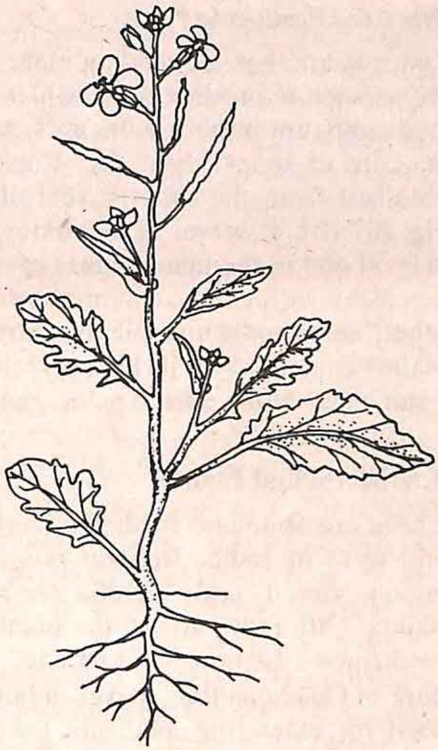


Fig. 8.7 (a) Mustard

restore the soil fertility. Groundnut oil is used as a cooking medium, as salad oil and margarine. Vegetable ghee is prepared from groundnut oil. The green portion of the plant is used as fodder. Crushed groundnut cakes after extraction of oil are used as food for animals or even mixed with flour for human consumption.

Mustard (Brassica)

Mustard fields are seen blooming yellow in the spring seasons. Bengal, Madhya Pradesh, Assam, Punjab, Haryana and U.P. are the major producers of mustard. It prefers a cool and moist climate Fig. 8.7(a). Seeds contain 20% proteins and 30-45% oil. Mustard seeds are used for flavouring vegetables and curries (condiments). The seeds are crushed to extract oil and the seed cakes left over are used as fodder while mustard oil is used for cooking and various other purposes.

Other Oil Producing Plants

Castor is another oil yielding plant. Its seeds are crushed to produce an oil which is used in medicines, automobile lubricants, in the manufacture of soaps, dyes, etc. Coconut oil is obtained from the dried kernel of coconut, Fig. 8.7 (b). It serves as a cooking medium, hair oil and in the manufacture of soaps, etc. Soyabean, a legume, and sunflower are the other oil producing plants. Soyabean is mainly cultivated for its high protein content. Palm oil is obtained from palm seeds.

(b) Coconut

8.8 Medicinal Plants

There are abundant medicinal herbs, shrubs and trees in India. *Digitalis purpurea*, Cinchona, sacred basil, mentha are some such plants. Different parts of the plants produce medicines. Quinine is extracted from the bark of Cinchona tree, leaves of purpurea are used for extracting medicine for heart diseases. Leaves of sacred basil (Tulsi) are used for treating sore throat and skin diseases. Extracts of Datura and poppy seeds in measured doses serve as effective pain killers and sedatives. Eucalyptus oil is good for sinus problems.

The eye-drop atropine is prepared from *Atropa belladona*. Amla, a rich source of vitamin C, is used in food preparations and in the manufacture of hair oil. The neem leaves have an antiseptic property. Hence they are used for making soaps, and for preparing medicines for skin diseases such as eczema, scabies, etc. The seeds and their husk of the Isapgul plant are a remedy for constipation and dysentry.

Activity 2: Find out the medicinal properties of:

i) Calendula
ii) Clove
iii) Garlic

8.9 Timber

Trunks of many flowering trees are of high commercial value. Wood for commercial purpose is known as **timber**. Timber from teak, deodar, sal and oak are used for making furniture and other articles of wood. Deodar wood is oily as well as durable. Telegraphic poles, buildings, railway sleepers are made of this wood as its peculiar smell keeps off white ants. Pine wood is soft and is used for making packing boxes, match sticks and common furniture. Our country's forest area is in Madhya Pradesh, Andhra Pradesh, Maharashtra, U.P., Assam, Jammu & Kashmir and Kerala. Wood in the form of saw dust is used in the paper industry.

8.10 Harmful Plants

Many plants are known to produce poisons. Poison can be described as a substance which is injurious to health or which can destroy life. The time scale for the effect of poison may vary. It may effect rapidly or it may work slowly and gradually, killing vital cells of the

body until perhaps after years the deadly effect is manifested. The poison may be found in one or other part of the plant, i.e., root, stem, leaf, flower or fruit. Half a spoon of the milky fluid of the calotropis plant can kill a small child.

White cedar is a small neem-like tree with attractive yellow fruits. These are lethal if taken by children and cause vomitting, diarrhoea and difficulty in breathing in adults. Datura poison, when administered in small doses over a long period can act as a slow poison. An overdose can cause death in minutes. Opium obtained from poppy seeds in mild doses serves as a sedative but an overdose can cause death.

Berries are attractive to children, but they can cause vomiting diarrhoea, pain, weakness and finally death in serious cases. Plants or their pollens are known to cause allergy. Allergy is defined as a state of increased sensitivity. Substances causing allergy are known as **allergens**. Only certain members of our race are sensitive and not all. *Hay fever* is generally caused due to the pollens in the air. When people inhale air, the pollens in it irritate the nasal membrane causing sneezing, runny nose, etc. In certain cases it may cause asthma. It is normally seasonal in occurence.

Direct contact with the parthenium weed gives rise to severe itching. Once the skin tissues have been stimulated it reacts by swelling either over a localized area or extensively. This weed too is known to cause asthma.

The first contact with the allergen usually has no visible effect. But on second or later contacts the body reacts violently against the allergens.

Some of the dicotyledonous weeds which grow in the rice or wheat fields withdraw nutrition from the soil. The crops lose their share of both nutrition and space. Thus weeds are harmful for the crop as they reduce the yield. The harm caused by fungi and bacteria have already been discussed in the earlier chapters.

EXERCISES

1. How is the land prepared for rice cultivation?

2. What factors affect the yield of the paddy crop?

3. What are the water requirements of the wheat plant?

4. Name the infections which affect the wheat crop and their remedies.

5. What are the various uses of the maize plant?

6. Sugarcane is useful to us in many ways. Elaborate.

7. What factors affect cotton cultivation most?

8. List the different uses of groundnut.

9. Give the medicinal property of the following:

(i) Eucalyptus

(ii) Cinchona

(iii) Isapgul

(iv) Neem

10. Plants can cause harm as well.

11. Match the following:

(i) *Triticum aestivum*	(a) are fed to the cattle.
(ii) Kharif crop	(b) causes allergy.
(iii) Seed cakes	(c) cultivated in order to obtain cash.
(iv) Parthenium weed	(d) botanical name of wheat.
(v) Cash crop	(e) grown in the rainy season.

9

Agricultural Practices and Implements

Man depends on plants and their products for his various needs. Since time immemorial he has been engaged in farming. Even today 70% of our population is engaged directly or indirectly in agriculture. The improvement of land and irrigation facilities for the cultivation of useful plants on a large scale is known as **agriculture.**

In order to raise a crop with a good yield a farmer has to carry out certain basic steps. During cultivation right from sowing seeds to harvesting, improved techniques are employed to produce high yielding, better quality and disease resistant varieties. Various scientific methods are employed for the improvement of quality and yield.

9.1 Soil Preparation

This is the first step towards the preparation for cultivation. Plants derive water and mineral salts from the soil with the help of their roots. So the soil is turned over by a few inches to loosen it and allow air into the layers of soil. This is known as **ploughing** or **tilling.** Ploughing not only helps the roots to breathe properly but also allows them to penetrate deeper into the soil. The ploughs are made of wood and iron and are generally driven by animals, Fig. 9.1. However nowadays most farmers use tractors to plough their fields.

The ploughs are chosen according to the type of soil. If the soil is hard the iron part of the plough must be sharp to break it. In dry conditions the soil breaks into big chunks or crumbs. These have to be further broken down and **clod crushers** are used for this purpose, Fig. 9.2. After the land has been tilled the top soil tends to get erodded by wind and water. To prevent this the soil is levelled with wooden levellers, Fig. 9.3. Water distribution is also facilitated by this. Another aspect of soil preparation is maintenance of its productivity. Continuous cultivation on a piece of land reduces its fertility.

If a particular crop is grown for many years, the soil becomes deficient in the particular nutrient taken up by that plant. Fertilisers are added to restore the soil balance. The elements which are of utmost importance to plants are nitrogen, phosphorus and potassium. These are added to the soil in the form

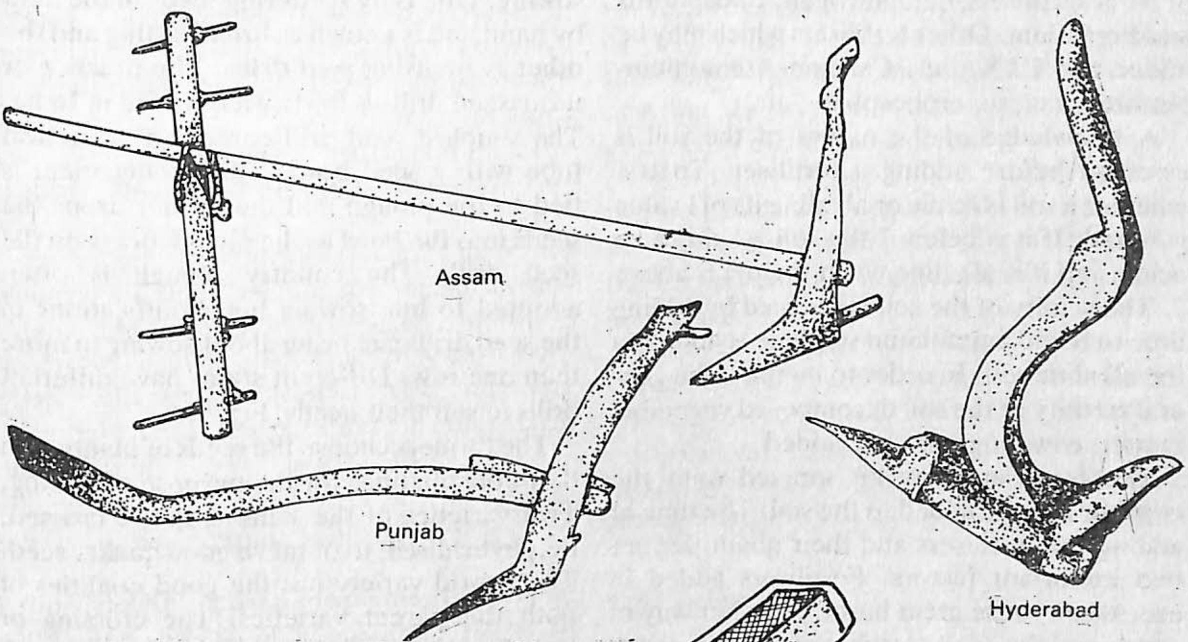


Fig. 9.1 Ploughs used in different parts of the country.

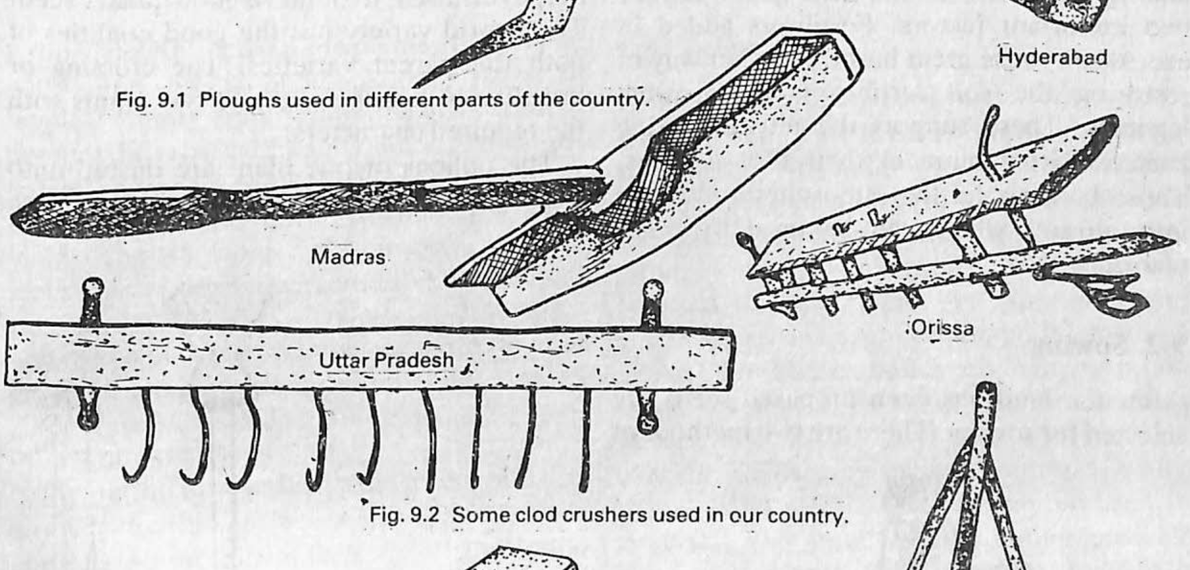


Fig. 9.2 Some clod crushers used in our country.

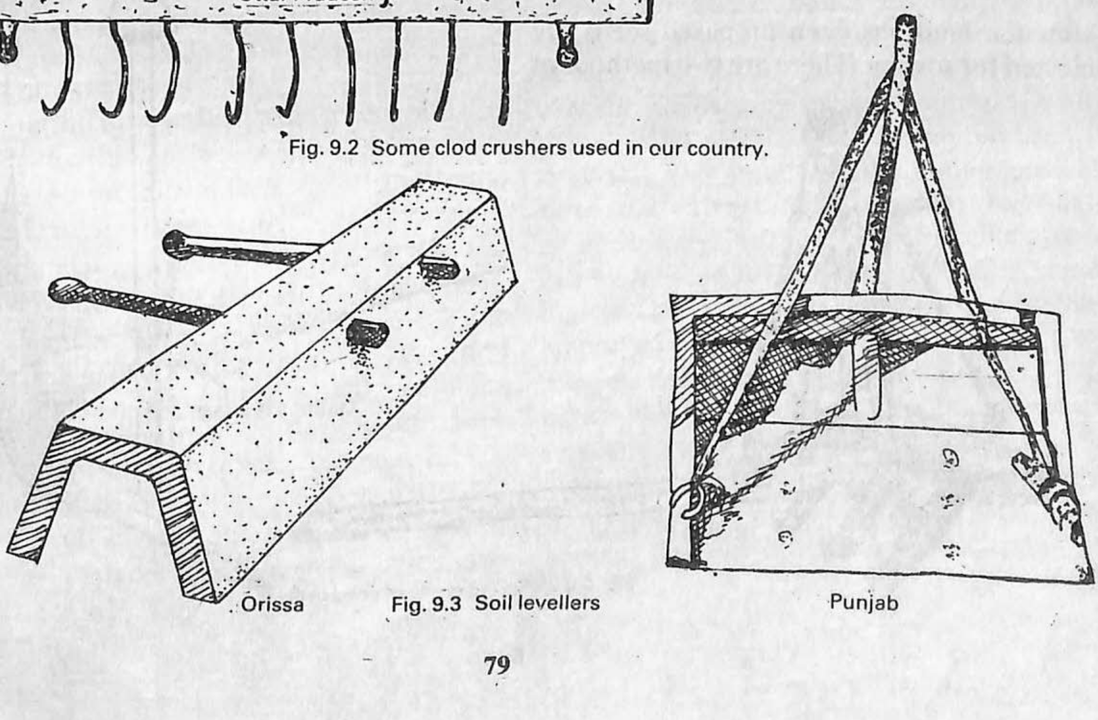


Fig. 9.3 Soil levellers

of **NPK** fertilisers, i.e., Nitrogen, Phosphorus and Potassium. Other fertilisers which may be added are CAN, i.e., Calcium-Ammonium-Nitrate, urea, superphosphate, etc.

A knowledge of the nature of the soil is essential before adding a fertiliser. To test whether a soil is acidic or alkaline its pH value is found. If it is below 7 the soil is said to be acidic and it is alkaline when the pH is above 7. The acidity of the soil is reduced by adding lime to it and ammonium sulphate is added to the alkaline soil. In order to increase the general fertility of the soil decomposed vegetable matter, cowdung, etc., are added.

The fertilisers may be sprayed onto the crops or may be added to the soil. The time of adding the fertilisers and their quantities are two important factors. Fertilisers added in excess can cause great harm. Another way of restoring the soil fertility is by growing legumes. These support the nitrogen-fixing bacteria, Rhizobium in their root nodules. These bacteria fix the atmospheric nitrogen into nitrates which can be used by other plants.

9.2 Sowing

After the land has been prepared seeds are selected for sowing. There are two methods of sowing. One is by scattering seeds in the field by hand and is known as **broadcasting** and the other is by using **seed drills.** The practice of using seed drills is fairly wide spread in India. The simplest seed drill consists of a vertical tube with a seed bowl. This arrangement is tied to the plough and the farmer drops the seeds into the bowl as the plough drags on the seed drill. The country plough is often adopted to line sowing but modifications in the seed drills can bring about sowing in more than one row. Different states have different drills to suit their needs, Fig. 9.4.

The farmers choose the seeds of plants with desirable qualities for the purpose of sowing. Two varieties of the same crop are crossed, i.e., **hybridised**, to obtain a good quality seed. The hybrid variety has the good qualities of both the parent varieties. The crossing or breeding is done by selecting two plants with the required characters.

The pollens of one plant are dusted onto the stigma of the other. If the plants have both

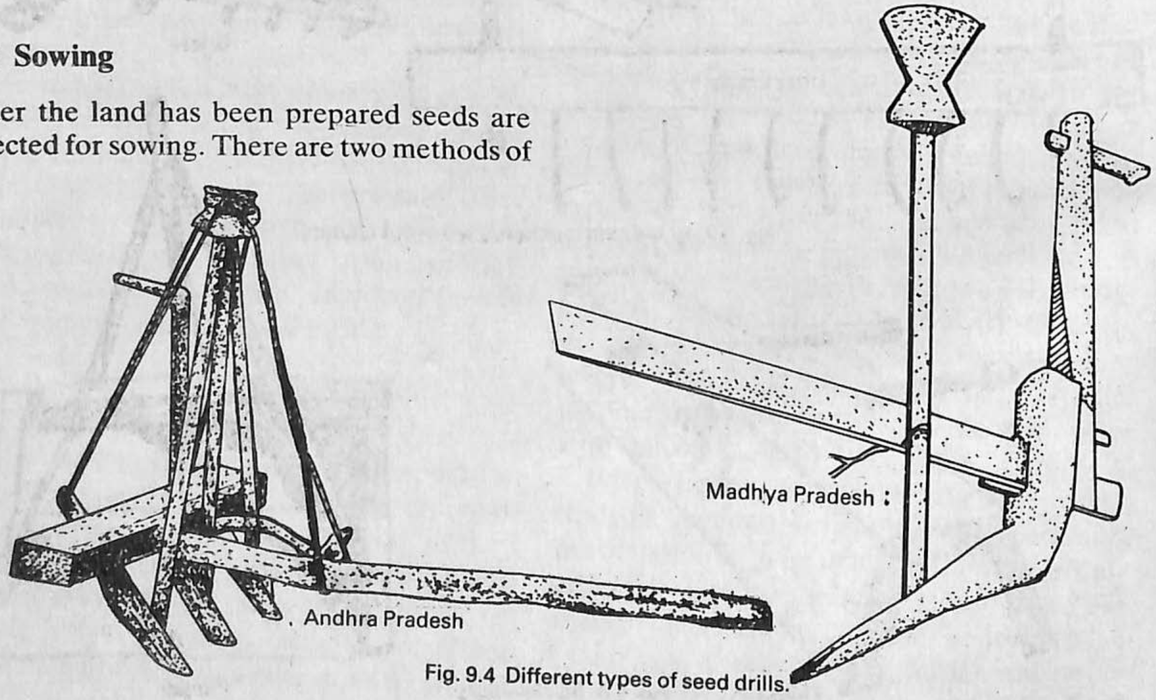


Fig. 9.4 Different types of seed drills.

the sexes their anthers are removed (**emasculation**). The pollinated flowers are covered in plastic bags. The seeds thus formed are sown and cultivated and another set of seeds are selected from these. After a few generations the characters become constant and then the seeds are finalised for sowing. Thus a new variety is evolved.

There are agricultural research institutes where good quality seeds are raised for distribution to farmers. Crops raised from these seeds are of high quality, as they provide a good yield and are disease resistant. The National Seed Corporation is one such organisation.

9.3 Crop Protection

Crop yield is affected if the plants are afflicted with some disease or attacked by pests. In tropical countries like India the environment favours the growth of weeds and spread of diseases. The weeds compete with the crop plant for moisture and nutrients and reduce the yield. The parasitic fungi, insects, such as locusts and grasshoppers,and rodents such as rats cause extensive damage to the crops, either as a plant or when in storage. Potential crop production is reduced by about 40% in Asiatic countries due to pests, diseases, insects and weeds.

Protection against the pests, weeds and diseases is done in various ways. Pesticides are sprayed on the plants to keep off the pests. The control measures are chosen keeping in view the type of plant, the disease and the causative agent and the part of the plant infected. Insecticides are used to check the insects while weedicides check the growth of weeds. Weeds are removed with the help of a harrow which has iron belt fixed to a wooden bar. It uproots the weeds when moved through a field.

Chemical control of all these harmful agents is very common though biological control is used as well. For example, the **cochineal** insect feeds on the weed **prickly pear** cactus and helps to recover valuable agricultural land. Bacteria which attack a particular pest but do not harm men and animals or other crop plants can be used as a means of check on the pest population. Biological control has an edge over chemical control as it has no side effects. In chemical control the insecticides may kill natural predators and useful bacteria as well.

Another disadvantage of using chemicals is that an overdose can harm the next crop and also affect the animals eating it. Research is being carried out as how best to control pests, insects and weeds without causing harm to the consumers.

9.4 Irrigation

It is the controlled application of water to crops to supplement the available soil moisture in case this is limiting the yield. Water should be supplied according to the needs of the particular crop. Fields can be irrigated either by canals, or by wells. Flood water can be used to supplement the rain water and water from rivers, and channelised through canals. **Terraces** or **bunds** are made to retain water for the crops which require standing water.

Some fields may be irrigated with water drawn from wells. Bullocks may be used to draw water. In some areas a rotating sprinkler head or a series of holes in a pipe are used to sprinkle water in the fields. But this system cannot be used for paddy as it requires standing water. In the case of paddy the method employed is known as **basin-irrigation.** Care must be taken to prevent waterlogging, i.e., excess of water in the soil. This excess water is removed through drains of mud or tiles.

In our country a large area is irrigated with water from tube wells. In order to prevent soil erosion the water flow may be checked by

making furrows or ridges in the field. The dams along the main rivers of our country provide water to many fields. Bhakra-Nangal, Hirakud and Damodar Valley projects are the major river valley projects irrigating our fields.

9.5 Harvesting and Threshing

The rabi or kharif crops are ripe at the end of their season. The fruits or grains are golden in colour and are ready for **harvesting** or **cutting**. Harvesting may be done either by hand with a **sickle** or with machines known as **combines**, Fig. 9.5. The stems of wheat, paddy or maize plants are cut to make hay and then the grains are separated from the chaff by threshing. Either the dried grains are threshed in the combines or animals are made to trod on them.

In case of hand harvesting the farmer is able to select his seed for the next crop. Regular harvesting not only ensures good yield but also prevents the build-up of certain diseases. For cereals the sooner they are harvested the quicker they are in store. The grains after harvesting are dried and fumigated with chemicals to keep off pests and insects. The grains are then stored in large bins or granaries in cemented halls called **godowns.** But the loss is maximum during storage due to rats and other rodents. So care must be taken to keep off these harmful agents.

9.6 Techniques to Improve Crop Production

Various practices are employed by farmers to better the yield. Over the years they have observed that the soil fertility is lost due to continuous cultivation. Also growing the same crop year after year makes the soil deficient in a particular type of nutrient. So the soil must be replenished with minerals to

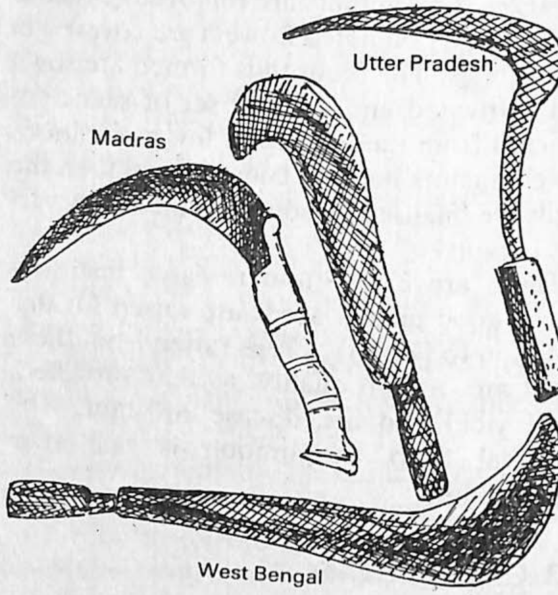


Fig. 9.5 Sickles for harvesting

restore its fertility. **Crop rotation** is a common practice carried out by farmers to counter the loss of fertility.

A leguminous crop is planted alternately or in **rotation** with the regular crop grown. These plants fix the nitrogen in the atmosphere into nitrates with the help of the bacteria housed in their roots. Thus the most important nutrient for crops is restored to the soil. Another practice to improve production is **multiple cropping.** Two crops are grown simultaneously in the same field. For example, mustard is grown on the raised ground between the furrows where wheat is grown.

In mountainous regions the favourable climate lasts for a short period. So short duration or early maturing crops are preferred for hilly areas. Certain chemicals called **hormones** are used to hasten the ripening of the crops. This ensures that the crops get harvested within the favourable season. In desert areas **dryfarming** is practised. Minimum quantity of water is used for the irrigation of crops in such areas. Pulses are grown by this method.

Thus, we see that farmers have devised ways of improving crop production based on their practical experiences. Nowadays agriculturists carry out research on varied subjects and lend their expertise to the farmers.

EXERCISES

1. Agriculture is:

2. How is the soil prepared for cultivation?

3. Only the seeds with desirable qualities are chosen for sowing. Elaborate.

4. What are the various factors which affect crop production?

5. Why is Biological control preferred to chemical control?

6. Define irrigation and state the different ways in which fields are irrigated.

7. Write a brief account of the techniques employed for improvement of crop production.

8. Match the following.

(i) Clod crushers	(a) The removal of the anthers from bisexual flowers.
(ii) Plough	(b) A leguminous crop planted in alternation with the regular crop.
(iii) Emasculation	(c) A means of biological control.
(iv) Broadcasting	(d) Used to break big chunks of soil.
(v) Crop rotation	(e) Is used to turn the soil over by a few inches.
(vi) Prickly pear cactus	(f) The sowing of seeds by hand.

10

Population

You have already learnt that living organisms depend upon one another and also on their surroundings. Let us take an example of a garden. In a garden you find trees such as gulmohar, neem, mango, etc., shrubs such as bougainvillea, rose, oleander; herbs such as chrysanthemum, marigold and grasses; various animals such as rats, mice, chameleons, garden lizards, birds and insects such as ladybirds and butterflies, Fig. 10.1.

In a particular garden there may be 10 gulmohar trees, 25 neem trees, 50 rose plants, hundreds of rats, thousands of ladybirds, etc. We say that the population of gulmohar trees in the garden is 10, the population of rose plants is 25, and so on. Thus a group of similar organisms belonging to one species such as gulmohar or neem or birds, living in a particular area, is called a **population**. But just a simple collection of large number of similar organisms is not a population. Population always consists of a single species. They must

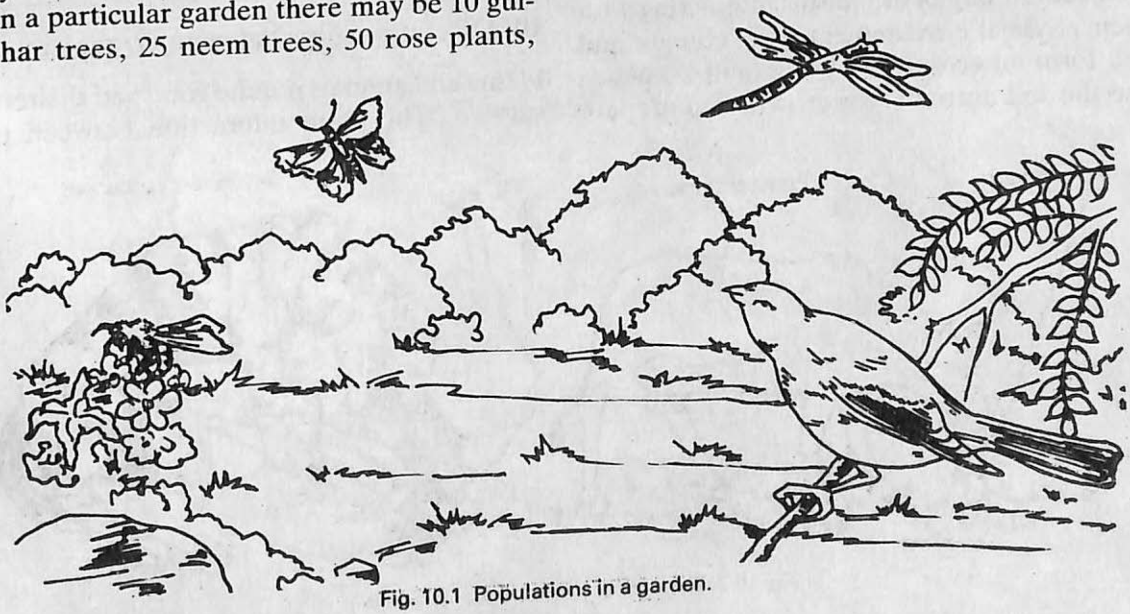


Fig. 10.1 Populations in a garden.

live for a period of time and must possess a well defined rate of birth, death, sexes and age structure.

Just as no living organism can exist by itself, no population can exist in isolation. Several populations of different species coexist in a particular area forming a **community**. It can be called a **biotic** community. It includes all the organisms within that area and their interactions. But a community is not a mere collection of interacting species. It has structure and stability. Tropical communities are very stable but those in severe environments show fluctuations in densities of population.

In a city park certain plants, birds, insects, worms, and small animals that make their home in the open grassy area, form one community. The pond in the park consists of another community of animals and plants, such as fishes, water insects, water plants, etc. In the countryside you can find many communities, each with its own plant and animal populations. Even a fallen tree can become a biotic community. The dominance of species within communities also vary. Some species are characterised by many individuals but others by only a few.

A community of organisms interacting with their physical environment, i.e., climate and soil form an **ecosystem**. For example, plants use the soil nutrients for growth and prepare their food from sunlight, water and carbon dioxide, i.e., the physical environment.

Activity 1: Make a list of the plants and animals living in your house and observe peculiar places where each of them stays. For example, rats may be present in the storeroom, cockroaches in the kitchen, etc.

10.1 Changes affect Populations

Any change in the environment brings about a change in the populations of that place. Cyclical changes, such as changes in the weather, etc., have a marked effect on the population. If a meadow or a wild land is converted into a field there would be new types of plants and animals that start living there. If a garden is not attended to, wild plants and animals will start living in it. Seeds of wild plants such as peepal, kikar, etc., brought in by birds will start growing in the untended garden. The grass, flowering plants, etc., will slowly disappear and a wild type of vegetation will take over. Such a change in an ecosystem is known as **ecological succession**.

10.2 Relationships between Organisms

Plants and animals require food and shelter to survive. The main interaction between the

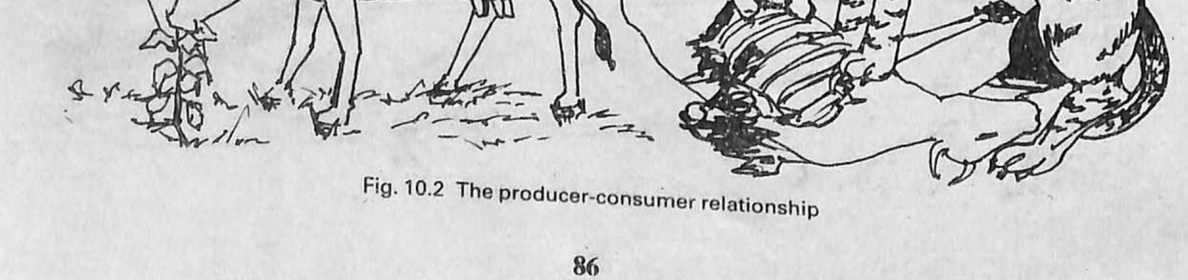
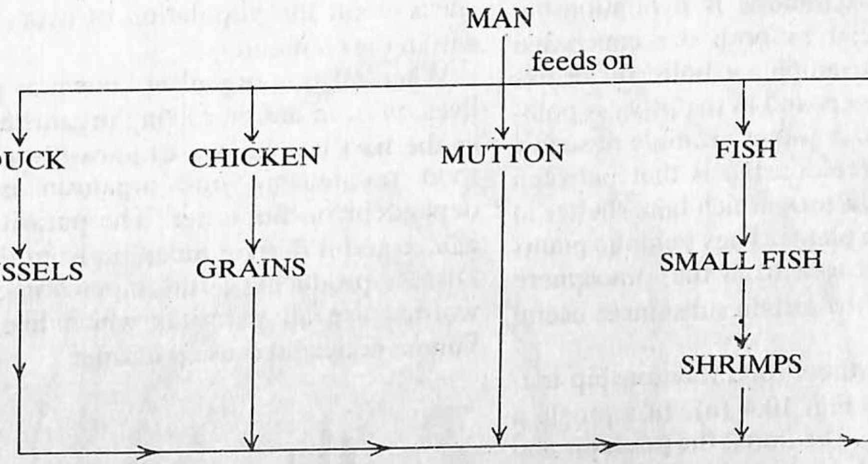


Fig. 10.2 The producer-consumer relationship

various populations of organisms is for food and shelter. No two populations of the same kind can inhabit the same area and have the same food habits. Thus the distribution and abundance of any population essentially depends upon its relationship with its environment.

The basic food link is that between the **primary producers**, the plants, and the animals. All animals consuming the plant products are called **consumers**. The herbivores feeding on plants are the **primary** consumers while the flesh-eating carnivores are called **secondary** consumers, as they are indirectly linked to the plants, Fig. 10.2. The herbivores such as deer, cattle are eaten by the carnivorous lions, tigers, cheetahs, etc. This is another link in the food chain.

The food chain is nothing but a chain of *who eats whom*. There are many such food chains and these interlink to form food **webs**. For example:



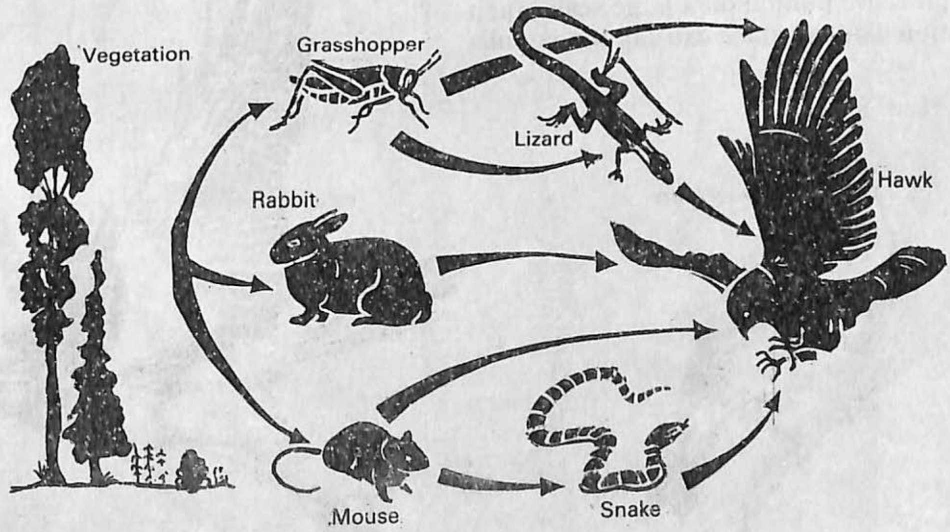


Fig. 10.3 A simplified food web.

Another such food web consisting of many food chains is shown in Fig. 10.3. What is common in both the food webs is plants. Thus they are the primary source of food to the entire animal kingdom. The plants utilise sunlight to prepare their food so the sun is the primary source of energy.

Apart from these food relationships there are other more complex ones. They may be useful to both the parties concerned or useful to one and harmful to the other. Let us study a few such relationships.

Mutualism or **symbiosis** is a relationship mutually beneficial to both the concerned organisms. For example, a butterfly drinks the nectar of flowers and in the process pollinates the flowers. Another example of such a 'give and take' relationship is that between certain types of bacteria which take shelter in the roots of pulse plants. They help the plants by absorbing nitrogen from the atmosphere and converting it to certain substances useful to the plants.

Predation is a direct food relationship between organisms, Fig. 10.4 (a). In a jungle a lion eats the deer. The lion is the **predator** and the deer the **prey**, in this relationship. If in a jungle lions are hunted on a large scale, their population would reduce causing the population of deer to increase. This would result in the destruction of the nearby fields by them for want of food. Man and other animals which depend on crops for their food would be deprived of it.

Similarly in the absence of birds, the insect population of a garden will increase. Thus the predators keep a check on the prey population within a community. In the absence of either the predator or the prey the balance of Nature would be lost. Nature has so devised these food relationships that it is a constant check upon the population of every species within the community.

When a living organism known as **parasite** lives *on* or *in* another living organism known as the **host** it is known as **parasitism**. In this food relationship one organism is solely dependent on the other. The parasite is the gainer and it derives nutrition from the host. Disease-producing germs, tapeworms, roundworms, are all parasites which live in the human body and cause it harm.

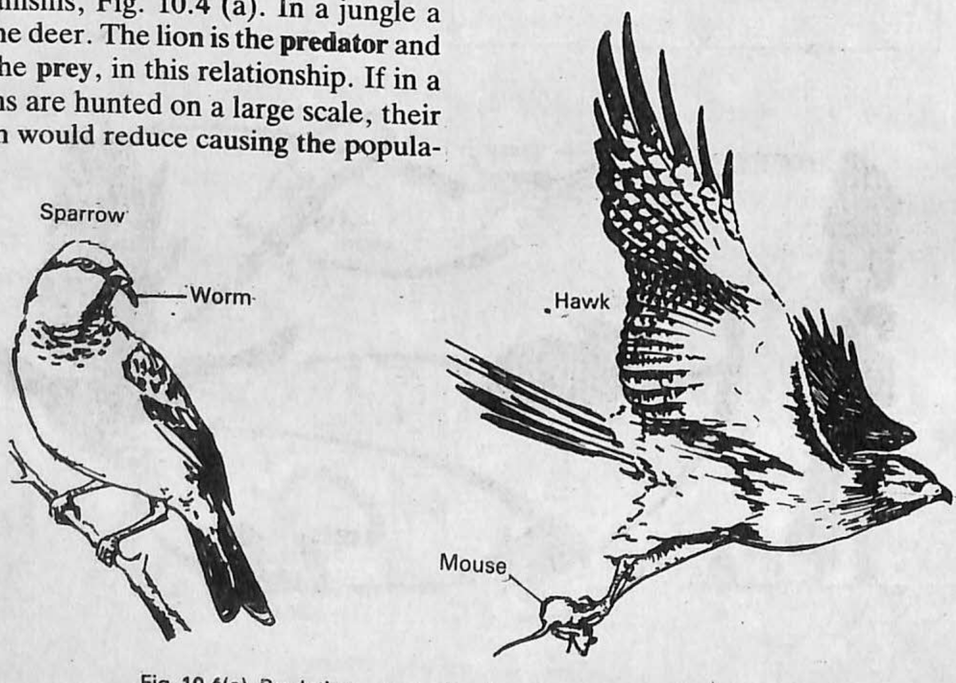


Fig. 10.4(a) Predation—a means of maintaining Nature's balance.

Animals such as vultures, hyaenas and jackals, feed on the dead bodies of other animals. They are known as **scavengers** and this phenomenon is known as **scavenging**. They are very useful as they keep our environment clean by feeding on the foul smelling dead bodies, Fig. 10.4 (b). You must have seen that left-over food smells bad and you say it has decayed. This decay is brought about by certain organisms called **decomposers**. These

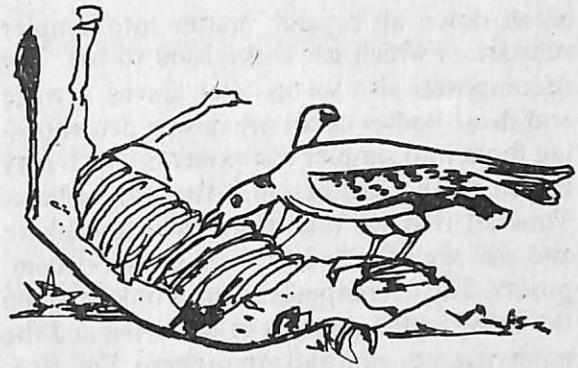


Fig. 10.4(b) Scavenger feasting on a dead body.

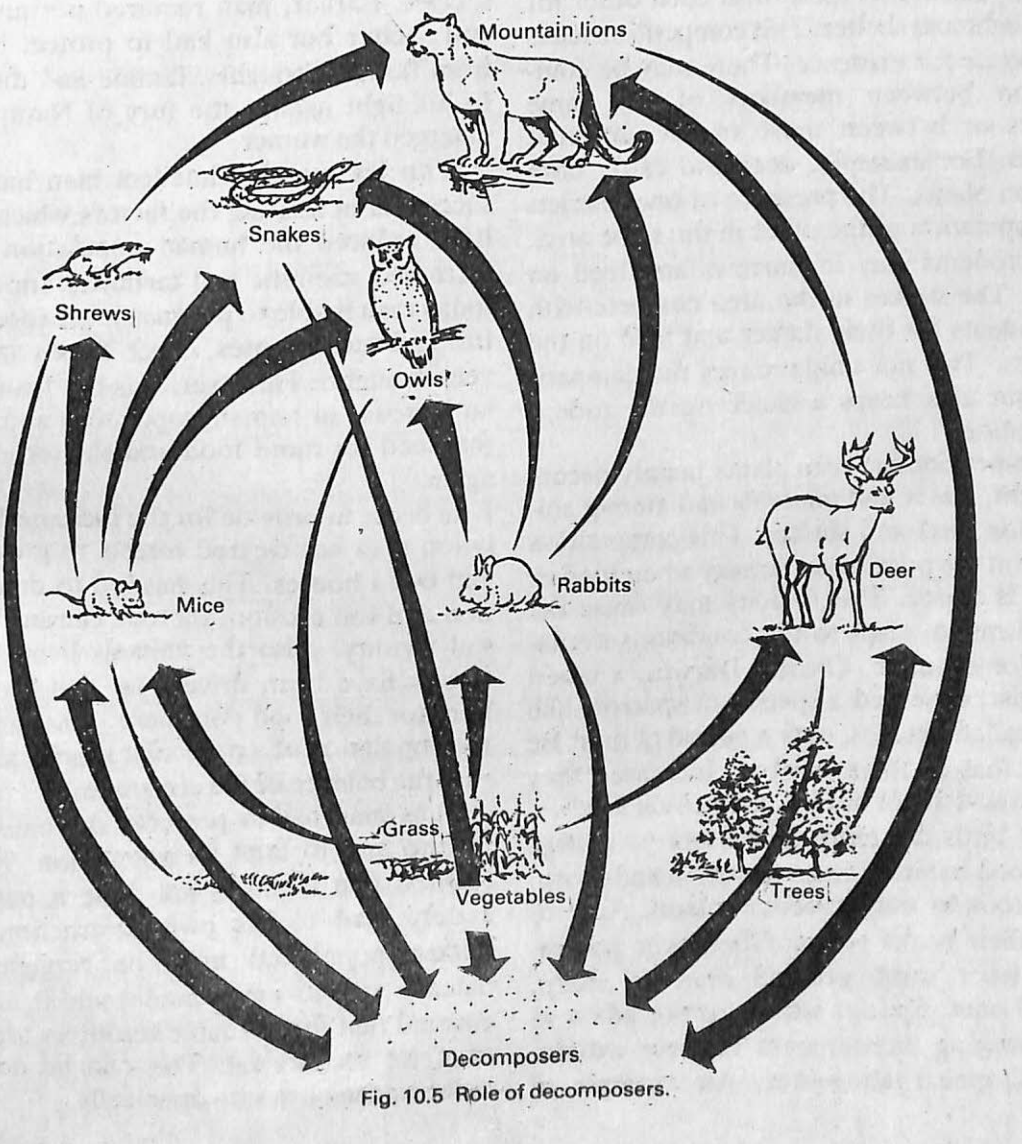


Fig. 10.5 Role of decomposers.

break down all organic matter into simpler substances which cause the food to rot. The decomposers also act on fallen leaves, sewage and dead bodies of all organisms decomposing them into simpler components which may return to the soil or enter the atmosphere. Thus all that we take from the atmosphere and soil are returned to them by the decomposers. The decomposers form a link between the living or the remains of the living and the nonliving, i.e., soil and atmosphere, Fig. 10.5.

Apart from these relationships, the different organisms compete with each other for food, light and shelter. This competition leads to *struggle for existence*. There may be competition between members of the same species or between those of two different species. For example, deer and cattle both feed on plants. The presence of one restricts the population of the other in the same area. Field rodents stay in burrows and feed on crops. The snakes in the area compete with the rodents for their shelter and feed on the rodents. This not only reduces the competition but also keeps a check on the rodent population.

Competition between plants mainly occurs for light, water and minerals and among animals for food and shelter. This competition can limit the population density when food or space is scarce. This scarcity may cause the organisms to adapt to the conditions available. For example, Charles Darwin, a noted biologist, observed a species of sparrow-like birds called Finches, over a period of time. He found that as their numbers increased they faced a scarcity of insects, their usual food.

The birds therefore had either to change their food habits or face starvation and death. They took to eating seeds of plants. Accordingly their beaks got modified over generations from small pointed ones to sharp, curved ones. Species which cannot adapt to the changing environment become extinct, i.e., disappear altogether. An example of such extinction is the dinosaur, which could not adapt to the changing climatic conditions. Thus Nature allows only the fittest to survive.

10.3 The Human Population

Like any other population, the human population is subjected to the laws that govern all life on earth. Man is part of a community, influencing and being influenced by, members of his own species and also those of other species. Earlier, man required not just food and shelter but also had to protect himself from floods, droughts, famine and diseases. In his fight against the fury of Nature man emerged the winner.

With his superior intellect man has been successful in limiting the factors which could have reduced the human population. With increased scientific and technical knowledge today man is able to produce more food, control and cure diseases, check floods and prevent droughts. However, this has resulted in an increase in human population and hence the need for more food and shelter all over again.

In order to provide for the increased population man has cleared forests to grow food and build houses. This has led to deforestation and soil erosion, thereby causing loss of soil fertility. Also the animals living in the forests have been driven out and forced to hunt for their food elsewhere. This can harm the population of a particular species and disrupt the balance of the ecosystem.

Thus man has to preserve the balance of Nature and to limit its population. He has realised that if this is not done it may ultimately lead to his own destruction. The human population must be brought into balance with its environment and it must be ensured that the available resources are sufficient for its survival. This can be done by reducing the birth rate drastically.

Activity 2: Make a survey of different organisms in a garden.

1. Select a garden near your house or school. Identify and make a list of the various living organisms in the garden. Try to find the population of each organism. One way of doing this is to divide the garden into different squares and to count the population in each square.
2. Observe the population during (i) winters (ii) summers and study the changes in population with weather changes.
3. Study the relationship of a particular population with its biotic environment for example:
   (a) birds as predators
   (b) ants as scavengers
   (c) fungus or worms as parasites on, say, plants.

EXERCISES

1. What is a biotic community and what are its characteristics? ______

2. An ecosystem is: ______

3. Explain the term ecological succession. ______

4. How are food webs different from food chains? Give an example. ______

5. With the help of an example explain how mutualism is beneficial to both the concerned organisms.

6. In the absence of the predator the balance of nature would be upset. How? ______________________________

8. Explain the role of decomposers. ______________________________

7. Scavengers keep our surroundings clean by: ______________________________

9. Match the following:

(i) Primary producer	(b) Link between the living and nonliving.
(ii) Food chain	(b) Live in or on a host body.
(iii) Parasites	(c) Plants.
(iv) Decomposers	(d) Who eats whom?

11

Pollution

We have seen that man is totally dependent on his living as well as nonliving environment for his survival. So he must live in harmony with his surroundings and maintain the balance of the environment. If someone were to disrupt this balance by adding harmful substances to it, it would endanger the lives of human beings and other living organisms. In fact this soiling or **pollution** of the environment by man himself is one of the major dangers facing human and other forms of life today.

With the increase in population, cities have become more congested and we face the problem of housing,and other requirements for better living. Also our food production has to be stepped up to meet the demand. For all this we need scientific advancements in agriculture as well as industries. Chemicals are used to prevent our crops from being damaged by pests, insects and rodents and to increase the yield. These poisonous chemicals may stick to the fruits and vegetables we eat and cause ill-effects.

Chemical wastes from the factories pollute land and water. Gaseous fumes from factories and automobiles pollute the air, even excess noise from traffic pollutes the calm of the atmosphere and is harmful to us. The wastes from nuclear reactors can give out rays which can cause immense harm to the animal population. Apart from the immediate damage such as crippling or death, these rays can spoil the quality of life by causing adverse hereditary changes, such as deformity of limbs, brain or even sterility. Thus pollution is an undesirable change in the environment that is harmful to human beings and other living organisms. Rapid industrialisation and population explosion are the root cause of pollution.

The substances causing pollution are known as **pollutants.** These pollutants are not necessarily waste materials. They may be used to enhance the yeild of a particular resource and they tilt the balance of some other constituent of the environment. The environment can withstand these changes upto a certain extent only. Beyond this limit the consequences can be grave.

Activity 1: Study the recent changes in your locality and comment on its effects on the environment.

11.1 Air Pollution

Air is necessary for all living organisms. Air

knows no boundaries and so it spreads unrestricted over large areas. Its pollution can therefore, cause serious lung and respiratory diseases such as asthma and lung cancer over a wide spread area. Air pollution is a great problem in congested, industrialized cities with heavy traffic, Fig. 11.1

Burning coal, motor vehicles and factories give out an extremely poisonous gas known as carbon monoxide. This gas affects oxygen absorption by our bodies. It can lead to headaches, loss of energy and even death on long exposure. Cigarettes, bidis and cigars all contain tobacco which on burning forms a chemical nicotine in the smoke. Nicotine coats the finger nails, nasal passage, food pipe and the lining of the lungs of the smokers. This leads to cough, sore throat, heart ailments and can even cause cancer. It is spe-

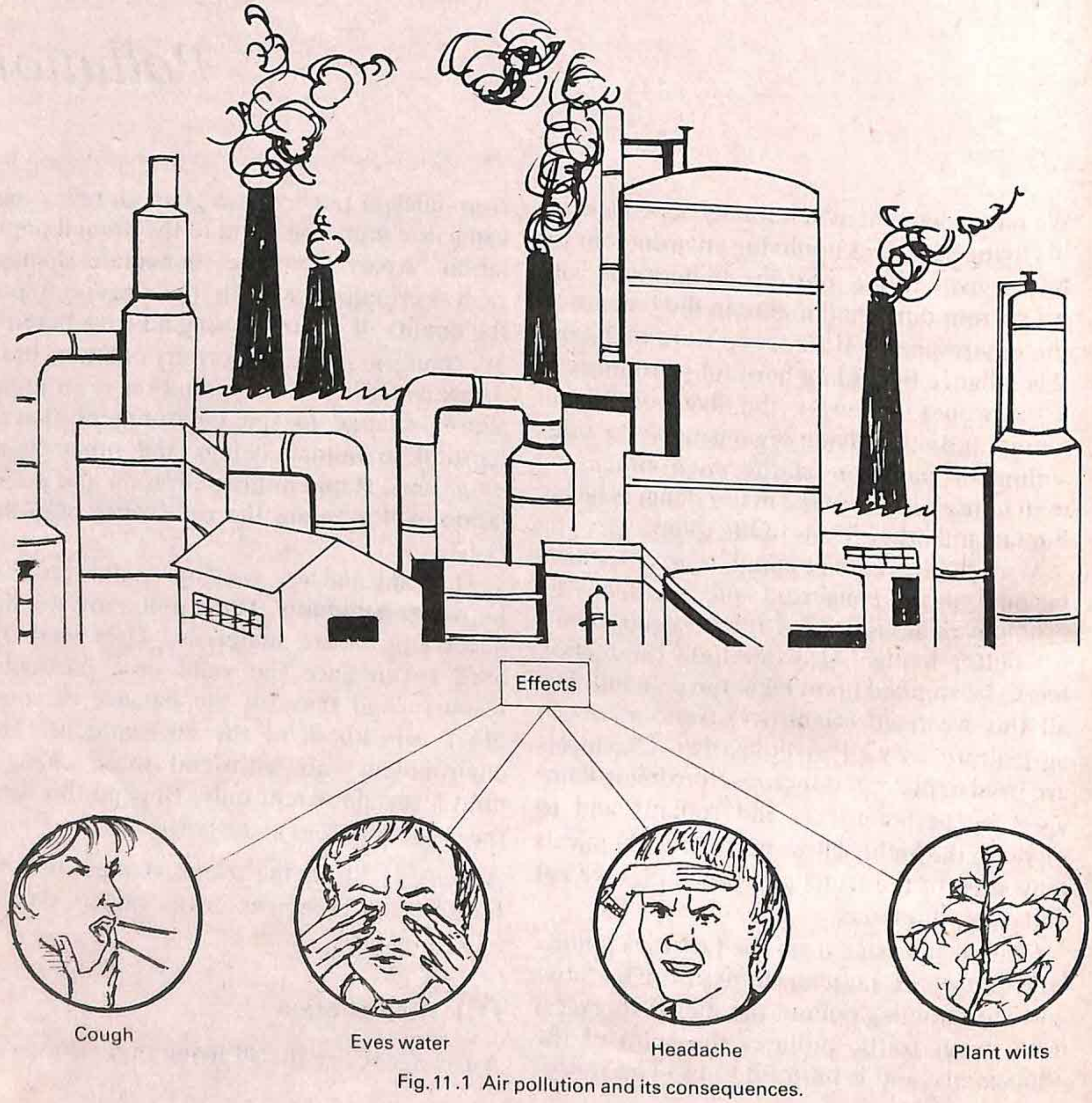


Fig. 11.1 Air pollution and its consequences.

cially harmful to small children and pregnant women.

A gas called sulphur dioxide is given out during the burning of coal. It is released in large quantities from power houses and other industries using coal. Sulphur dioxide causes irritation in eyes, throat, nose and lungs, and can lead to various diseases . Sulphur dioxide also damages leaves of plants. We know that plants cleanse the air around us by taking in carbon dioxide and giving out oxygen during photosynthesis. Since air pollution affects the leaves of plants, they are not able to carry out this function properly. This makes the effect of pollution even more serious.

Smoke or fly ash given off during burning of coal, or exhausts from motor vehicles contain small carbon and dust particles. These remain suspended in the air and seriously affect our respiratory system. They also reduce visibility and cause irritation in the eyes. The ultraviolet radiations from the sun are filtered by the ozone layer of the outer atmosphere. Air pollution leads to the thinning out of this protective ozone layer. The unshielded ultraviolet rays reach the earth and can cause damage to life on earth. Scientists believe that this may lead to an increase in the number of cancer patients.

You may have heard of the terrible tragedy due to air pollution that occured in Bhopal during 1985. A poisonous gas (methyl isocyanide), used in making insecticides leaked from a factory and the air pollution it caused, killed thousands of men and animals. Several of those who survived suffer from severe diseases.

Air pollution caused by factories can be minimised by using 'filters' in chimneys. These filters absorb poisonous gases and particulate matter. Similar filters can be fixed to the exhausts of motor vehicles to minimise air pollution by automobiles. We can also contribute to reducing air pollution by not smoking, specially in public places.

11.2 Water Pollution

We require water for drinkir, washing, cooking and irrigation. The major sources of water are rivers, lakes, wells, streams, etc.

The Water Cycle

Water is constantly being circulated from the earth's surface to the atmosphere and back to the earth. This process is known as the **water cycle.** Water is constantly going into the atmosphere by the process of evaporation from oceans, rivers and lakes. The water vapour condenses to form clouds and returns to the earth in the form of rain, snow and hail. Some of the water percolates through the soil and collects to form underground water deposits when it reaches underground rocky layers. The roots of plants take in water retained by the top layer of soil.

If at any stage, some foreign matter is added to water, that makes it less suitable for drinking, domestic, agricultural or other purposes, it is said to be polluted. The major sources of pollution of water are as follows:

Industrial wastes from factories are discharged into rivers, Fig11.2. This is the major cause of water pollution. It introduces toxic substances in the water harmful to living organisms. This kills fishes and other animals. The decomposition of the dead bodies of fishes and animals consumes oxygen. This adds to pollution as aquatic plants and animals now die due to shortage of oxygen in the surrounding water.

Insecticides, fungicides and fertilizers get washed into streams and lakes because of rain. This also causes water pollution as it leads to growth of aquatic plants which use up oxygen, dissolved in water. High concentration of DDT, an insecticide, has been discovered in the bodies of fishes in several places. This makes them unfit for human consumption. In 1969, mercury, which is a byproduct in the manufacture of agricultural fungicides,

Fig. 11.2 Causes of water pollution.

caused pollution in Menamada Bay killing several people.

Sewage dumped in river waters is another cause of water pollution. This renders the river water unfit for human consumption. It causes waterborne diseases such as typhoid, cholera, dysentry, etc. It also encourages the growth of bacteria and fungi which use up the oxygen dissolved in water thereby causing harm to aquatic organisms. Also the bacteria and fungi decompose the dead bodies of aquatic organisms. They release the products of decomposition into the river water thereby polluting it further.

In villages, bathing and washing near ponds and rivers cause dirty water to flow back into them. This dirty water if consumed, leads to waterborne diseases. You may be aware that the pollution of rivers,such as Yumuna and Ganga, has reached alarming proportions. The government has taken up a large project to reduce pollution in the Ganga.

To reduce water pollution industrial wastes should be filtered of all toxic substances before they are allowed to be discharged in rivers. Better still, alternative ways of disposing wastes should be discovered. Proper sewage disposal facilities should be provided. We should also observe cleanliness in our homes and surroundings and should not allow dirty water to get mixed up with drinking water.

11.3 Noise Pollution

People living near the main road will know how irritating the constant rumbling of traffic and blaring of horns is. This increase of noice in the environment is called **noise** pollution. It can lead to high blood pressure, hearing problems leading to deafness, loss of sleep, headache, nervous disorder, etc. Machines, vehicles, trains, aeroplanes, loud music are all sources of noise pollution.

Better 'silencers' should be designed to reduce noise coming from machines and automobiles. We should also not indulge in playing loud music or talking loudly in public places.

11.4 Soil Pollution

When certain substances adversely affect the quality of the soil and thereby the growth of plants and trees, it is known as **soil** pollution. Indiscriminate use of fertilizers, pesticides, fungicides, etc., pollute the soil as these chemicals kill the useful bacteria present in the soil and hamper the growth of the plants. We know that plants produce food for human beings and animals. Growth of plants depends on the top layer of the soil, known as **top** soil which provides the necessary nutrients. Thus the richness of a nation may be judged from the nature and quality of its top soil.

Roots of trees and plants bind the top soil. Thoughtless cutting of trees and plants causes the top soil to be washed away by the forces of nature such as wind, rain and water currents. Removal of the top soil by these forces is known as **soil erosion.** This leads to loss of soil fertility which in turn reduces our food production and also causes desert formation. Loss of top soil causes the rain water to either flow down the slopes or swifty percolate to the lower layers. This causes the rivers and ponds to dry up in summers and overflow in rainy seasons.

To retain the top soil we have to prevent **deforestation**, i.e., thoughtless cutting of trees. We also need to plant more trees to bind the top soil. Dams may be constructed to prevent the rivers from overflowing and carrying away the top soil with them.

11.5 Waste Material can be useful

One very useful method of reducing pollution is the 'recycling of waste'. For example, old papers, copper, aluminium, plastics, etc., can be taken out from garbage and used again or '**recycled**'. One very effective method of reducing pollution in villages, is by using vegetable peels, cow dung, etc., for producing 'gobar gas'. The use of this 'gobar gas' instead of coal for cooking results in reduction of air pollution, as burning of coal releases sulphur dioxide and carbon monoxide.

If we want to live in harmony with our environment we have to reduce pollution. On our part we have to make considerable effort to keep our surroundings clean. A lot of scientific research is also necessary in proper utilisation and disposal of waste materials.

EXERCISES

1. What do you mean by pollution? ______________________________

____

____

2. Pollutants are: ______

3. Major causes of air pollution are: ______

4. In what way do industrial wastes dumped into rivers pollute their waters? ______

5. Noise pollution can lead to: ______

6. How does soil pollution affect us? ______

7. Choose the correct word.
   (a) To prevent the rivers from overflowing (bridges/dams) may be constructed.
   (b) Removal of the top soil is known as (soil conversion/erosion).
   (c) Air pollution causes the ozone layer to (increase/decrease).
   (d) Filters may be used in chimneys and exhausts of vehicles to reduce (water/air) pollution.
   (e) Burning coal, vehicles and factories give out a poisonous gas called (carbon monoxide/carbon dioxide).

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